P - ISSN : 2722 - 0133
E - ISSN : 2722 - 0141

Indonesian Journal of Applied Environmental Studies

Volume 4 • Number 1 • April 2023

Co-Published by

Pakuan University

Cover Photo : The white-throated kingfisher (*Halcyon smyrnensis*) in the mangrove forest of Muara Kambas, Way Kambas National Pak, Lampung, Indonesia. It was photographed in April 2021.
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Published biannually

P-ISSN: 2722 - 0133 E-ISSN: 2722 - 0141

Indonesian Journal of Applied Environmental Studies

P - ISSN: 2722 - 0133 (printed edition)
E - ISSN: 2722 - 0141 (electronic)
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The Indonesian Journal of Applied Environmental Studies is co-published by Graduate School of Environmental Management, Pakuan University, Indonesia and Perhimpunan Cendikiawan Pemerhati Lingkungan Indonesia (PERWAKU) in collaboration with Belantara Foundation. It is an open access journal available at: **https://journal.unpak.ac.id/index.php/InJAST/index**

Indonesian Journal of Applied Environmental Studies (InJAST) would like to express its gratitude to the people below for their invaluable services as peer-reviewers on this issue of the journal:

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InJAST
Volume 4, Number 1, April 2023
Pages: 1-2

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.7441

GUEST EDITORIAL

How about nano? Impact of size of plastics on plastic pollution and the magnitude of the problem

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Submitted 01 April 2023; Accepted 13 April 2023

INTRODUCTION

In the last decade we have realized that the plastics we use every day, and for practically everything, may be the biggest environmental polluters humans have ever released to the environment (EU DG, 2011). Since the first reports of plastic pollutions, we have learned so much about the issue. Macro and micro plastic pollution topics have been extensively studied, investigated, regulated, and in some cases litigated (Uren Webster et al., 2020)(Barnes, Galgani, Thompson, & Barlaz, 2009)(Environment Agency, 2018). As it happened in most of the past cases, we have started with the most obvious and visible problem: macro plastics.

Macro plastics: It is very easy to detect a macro plastic pollution, because of their sizes, and it is relatively easy to remove them from the environment. How hard it is to pick up plastic bottles from the beach or collect disposed masks from the side of a road? The impact of macro plastics is also limited to physical ones. Sharp plastics hurting internal organs of the marine animals or wrapped plastics slowly choking sea turtles are some of the most common examples we can see in the nature. However, because majority of the common plastics are non-toxic and not chemically active, there have been no (or very little) evidence that macro plastics have toxic impact on the environment (Barnes et al., 2009).

The importance of the topic and severity of the scale of the global plastic pollution led researchers to look at smaller plastic particles, especially the ones which are small enough to escape traditional detection: micro plastics.

Micro plastics: Microplastics are often described as plastics with size smaller than 5 mm (Sullivan et al., 2020a), and they are much harder to detect compared to macro plastics. In the past decade, researchers developed many techniques to detect and characterize micro plastics. One of the most common methods is to use a plankton net and visually confirm/count the plastics (in water sources) trapped in the net (EU DG, 2011). However, this method cannot tell us what type of plastic is in the water. The solution to this problem was to use thermal degradation combined with gas chromatography, and pyrolizer-GC-MS was found to be one of the most powerful analytical methods to identify plastics found in water sources. (Sullivan et al., 2020b). There were also number of research projects looking at the introduction of micro plastics in food chain and the impact of them to animal and/or human health. Even though the evidence of microplastics in digestive tracks of aquatic animals and humans were found, the direct impact of microplastics was never proven. The main reason behind this is the size of the plastics. As it is well known that most plastics are resistant to mild oxidation and chemically inactive chemicals (inert), therefore they can pass through the digestive tracks without any changes and can be easily excreted.

However, this changes when the particle, inert or not, is smaller than 100nm (Delgado-Gallardo et al., 2022). In the last 7-8 years we have seen evidence that nanoparticles (smaller than 100nm in size) can have a detrimental impact on the animal and human health. Any particle smaller than 100nm in size can potentially penetrate the cell of a living organism. For example, silicon oxide particles can cause cell death and can start cancerogenic formations in the cell they penetrated into (Delgado-Gallardo et al., 2022).

NANOPLASTICS

When I first started working on plastic pollution topic in 2017, the only question in my mind was 'What if there are nanoplastics in the nature but we cannot detect them?'. I started working on a method which can enable me to detect nanoplastics in water. After months of study and investigation, the solution I have found was:

- Filter the water (with plastics in it) with a nanofiltration membrane (pore size < 100nm)
- All the particles bigger than 100nm will be deposited on the membrane

- Laser cut the membrane to small pieces, which can be fed into pyrolizer tubes
- Pyrolyze the membrane with plastics and pass it through GC-MS
- Separate plastic peaks from membrane material peaks
- Identify the type of plastics

We have tested this method with model solutions (plastic dosed DI water) and validated it with actual river water (Tawe River, UK) (Sullivan et al., 2020b). The results were astonishing, we have detected Polystyrene in River Tawe, which was not detected with common microplastic detection methods. In addition to this, we have also semi quantified polystyrene by using analytical data.

What happened after was something no one was expecting: Covid 19. We had to change our approach and focus on Covid 19 and its impact on environment. We have decided to look at the durability and fate of disposable plastic masks in environment (Sullivan, Delgado-Gallardo, Watson, & Sarp, 2021). During Covid era, we have seen disposable plastics masks being littered, thrown away, and piled on landfills. Our main focus was the amount of nanoplastics released from these masks when these masks exposed to water (rain, runoff, ocean, etc.). Our study showed that, each one of these masks' releases at least 1000s of micro and nano particles to environment, and most of these cannot be detected with common methods. We have also proved that these masks emits nano silicon particles and heavy metals as well, including Arsenic and lead (Delgado-Gallardo et al., 2022; Sullivan et al., 2021).

CONCLUSION

Plastic problem is much bigger than we currently understand. The magnitude of the problem is coming from the size of the plastics in the environment. We are being exposed to nanoparticles from textile products, car tires, cosmetic products, and even personal protection equipment (masks etc.). There is a lot of research to be done and a lot of regulations to be implemented by governments.

REFERENCES

Barnes, D. K. A., Galgani, F., Thompson, R. C., & Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1526), 1985–1998*. https://doi.org/10.1098/rstb.2008.0205

Delgado-Gallardo, J., Sullivan, G. L., Tokaryk, M., Russell, J. E., Davies, G. R., Johns, K. V., … Sarp, S. (2022). Disposable FFP2 and Type IIR Medical-Grade Face Masks: An Exhaustive Analysis into the Leaching of Micro- and Nanoparticles and Chemical Pollutants Linked to the COVID-19 Pandemic. *ACS Environmental Science and Technology Water, 2(4), 527–538*. https://doi.org/10.1021/acsestwater.1c00319

Environment Agency. (2018). The State of the Environment: Water Resources, (May), 1–12. Retrieved from www.gov.uk/environment-agency

EU DG. (2011). Plastic Waste: Ecological and Human Health Impacts. *Science for Environmental Policy, In-Depth Reports*, (November), 41.

Sullivan, G. L., Delgado-Gallardo, J., Watson, T. M., & Sarp, S. (2021). An investigation into the leaching of micro and nano particles and chemical pollutants from disposable face masks - linked to the COVID-19 pandemic. *Water Research, 196*. https://doi.org/10.1016/j.watres.2021.117033

Sullivan, G. L., Gallardo, J. D., Jones, E. W., Hollliman, P. J., Watson, T. M., & Sarp, S. (2020a). Detection of trace sub-micron (nano) plastics in water samples using pyrolysis-gas chromatography time of flight mass spectrometry (PY-GCToF). *Chemosphere, 249, 126179*. https://doi.org/10.1016/j.chemosphere.2020.126179

Sullivan, G. L., Gallardo, J. D., Jones, E. W., Hollliman, P. J., Watson, T. M., & Sarp, S. (2020b). Detection of trace sub-micron (nano) plastics in water samples using pyrolysis-gas chromatography time of flight mass spectrometry (PY-GCToF). *Chemosphere, 126179*.

Uren Webster, T. M., Rodriguez-Barreto, D., Castaldo, G., Gough, P., Consuegra, S., & Garcia de Leaniz, C. (2020). Environmental plasticity and colonisation history in the Atlantic salmon microbiome: A translocation experiment. *Molecular Ecology, 29(5), 886–898*. https://doi.org/10.1111/mec.15369

InJAST
Volume 4, Number 1, April 2023
Pages: 3-9

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141

NEWS, NOTES, & EVENTS

Progress, Challenges, and the Nexus of Research and Impact - the importance of technology in biodiversity conservation in Indonesia

DOLLY PRIATNA and **KATHRYN A. MONK**(Eds.)

We are delighted to announce that the Indonesian Journal of Applied Environmental Studies (InJAST) has now received national accreditation (SINTA 4), just three years since its inaugural issue in April 2020. This accreditation, granted through the Decree of the Director General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology of the Republic of Indonesia No. 204/E/KPT/2022, is a testament to the increasing quality of research contributions published in our journal. With this status, we are committed to further enhancing the caliber and range of articles featured within these pages. We extend our sincere appreciation and gratitude to all those who have supported and facilitated the establishment of InJAST, providing a novel platform for academics and researchers to disseminate their scientific results.

In the middle of this celebration, however, we are also saddened at the recent passing of a senior member of our editorial team, Professor Endang Sukara. A distinguished microbiology expert who championed our cause since InJAST's inception, Professor Sukara passed away in January 2023 at the age of 70. The entire InJAST editorial team offers its heartfelt condolences to his family and friends. We will build on his legacy of dedication to fostering a culture of scientific article publication and effective management of scholarly journals.

In this edition, we publish an array of articles encompassing pressing concerns such as environmental pollution and wildlife conservation. Among the subjects tackled is the issue of microplastic contamination in our oceans, posing a significant threat to marine biodiversity. Additionally, we see the transformative impact of camera trap technology, instrumental in the rediscovery of wildlife presumed locally extinct in the Gunung Gede Pangrango National Park, West Java, Indonesia. Another contribution details the deployment of radio-trekking technology to investigate the behavior of Javan slow lorises following their rehabilitation and release into their natural forest habitat.

The Global Assessment Report on Biodiversity and Ecosystem Services 2019, published by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), shed light on the increasingly alarming state of global biodiversity. Biodiversity is essential to human survival through its contribution to ecosystem stability, resilience, and the provision of critical ecosystem services that sustain essential ecological processes and human well-being. Amongst other services, as demonstrated across Indonesia, biodiversity supports livelihoods by providing building and clothing materials, maintaining water quality, and providing medicines and food.

Indonesia has a strategic position both geographically and politically in safeguarding global biodiversity. Recognised as one of the world's "megadiverse countries," it is the second most biodiverse country in the world after Brazil and a focal point for demonstrating the sustainable management of biodiversity and other natural resources, and for addressing climate change consequences. Comprising over 17,000 islands with a coastline of approximately 81,000 km, Indonesia also ranks second globally in coastline length after Canada. A mosaic of 47 distinct natural ecosystems and a rich diversity of plant and wildlife species that includes numerous endemics, further underscore Indonesia's biological significance.

Within Indonesian borders, we are custodians of 10% of the world's flowering plants, 15% of all insects, 25% of fish species, 16% of amphibians, 17% of avian species, and 12% of mammals. The existence of our Indonesian biodiversity, however, continues to be exposed to an array of acknowledged threats. Foremost among these is habitat loss, a consequence of degradation and deforestation caused by various agents including natural disasters, forest fires, pollution, climate change, and the conversion of forestland for agricultural, industrial, and residential purposes. Equally important is hunting associated with the illegal wildlife trade.

Observations by conservation practitioners have shown a disturbing surge in the global wildlife trade, particularly during the COVID-19 pandemic. While jeopardizing iconic species like tigers and elephants, this primarily illegal trade equally threatens various smaller size species, such as fish, reptiles, and birds.

The Fourth Industrial Revolution (the emergence of which was recognised by Klaus Schwab in a World Economic Forum article in 2016)[1], marking the age of digitalization, big data, the Internet of Things (IoT), robotics, and cloud systems, has also influenced biodiversity conservation. Employing technology to address challenges such as the dwindling populations of Sumatran rhinoceroses, has spurred the development of

[1]https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Assisted Reproductive Technology.

To combat wildlife crimes, innovative computer software now charts criminal networks engaged in wildlife trafficking. In tandem, DNA barcoding is harnessed to discern evidence of wildlife crime, matching confiscated samples to genetic databases. Artificial Intelligence (AI) has proven crucial for detecting intrusions by poachers into wildlife habitats. Furthermore, bioacoustics technology is employed for ecological and taxonomic research, radio telemetry (such as VHF tracking, GPS tracking, and satellite tracking) to study wildlife populations, camera traps to monitor wildlife in the forest and differentiate between individuals, and micro-tags to track the migration of sea turtles that travel across oceans.

As the global human population reached 8 billion in 2022, the interconnections between our unsustainable production and consumption, the climate crisis, and biodiversity decline have been increasingly recognized by the global community through IPBES and IPCC (Intergovernmental Panel on Climate Change). Escalating human numbers, coupled with burgeoning economic and industrial demands, must necessitate substantial forest land use—repositories of biodiversity. Conservation practitioners have therefore been continually driven to innovate in their pursuit of effective strategies for sustainably managing the world's precious biodiversity.

Researchers and academics have the pivotal responsibility to produce research that brings about real-world impactful outcomes. The academic community is expected to address the needs of those working to conserve nature through the development of research and technology with immediate practical applicability. We look forward to publishing more of these research impact papers in the future.

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NOTES

Fingermarks in wildlife forensics: A review

Wildlife forensics is defined as providing forensic evidence to support legal investigations involving wildlife crime, such as the trafficking and poaching of animals and/ or their goods. While wildlife forensics is an underexplored field of science, the ramifications of poaching can be catastrophic. The consequences of wildlife crime include disease spread, species and habitat loss, human injury, and cultural loss. Efforts to use forensic science to combat poaching are currently limited to DNA-based techniques. However, fingermark analysis for the identification of perpetrators of wildlife crimes has not been explored to the same extent, despite being a cost- effective, simple-to-use forensic method that is easy to deploy in-field. This review covers literature that has explored fingermark examination techniques used on wildlife-related samples, such as pangolin scales, ivory-based substances, bone, and eggs, as well as feathers and skins, among more obscure trafficked items. Useful preliminary work has been conducted in this subject area, demonstrating that commonly used fingermark analysis techniques can be applied to wildlife-based items. However, many of these studies suffer from limitations in terms of experimental design. More work should be done on creating studies with larger sample sizes and novel approaches should be validated under environmental conditions that mimic real crime scenes. Further research into determining the forensic fingermark analysis techniques that perform the most efficiently in the environmental conditions of the countries where they are needed would therefore benefit legal investigations and help to reduce instances of poaching.

Woodcock, Lauren et al. (2023). Fingermarks in wildlife forensics: A review. *Forensic Science International*, 350 (2023): 111781
https://doi.org/10.1016/j.forsciint.2023.111781

Wildlife and human safety in the Tarangire ecosystem, Tanzania

Coexistence of people and wildlife outside protected areas is of critical conservation importance. However, human-wildlife interactions on shared landscapes can produce negative outcomes for wildlife populations and people. This article focuses on the effects of wildlife on local people's lived experiences of physical safety in the Tarangire ecosystem of northern Tanzania. The Tarangire ecosystem supports a diverse array of wildlife species of global conservation significance, encompassing several national parks, community-based conservation areas, forest reserves, and trophy hunting blocks. From the perspectives of local agropastoral Maasai communities, coexisting with wildlife is a routine part of everyday life, though some species are dangerous

and pose threats to physical safety. These human security concerns compound the economic impacts of wildlife on local livelihoods, manifest in the forms of crop raiding, livestock depredation, and property damage. Based on mixed qualitative methods including ethnographic fieldwork (2019–2020; 2022; 2023), participant observation, household surveys (n = 1076), and in-depth interviews (n = 240), this paper identifies the species of particular concern to communities. Elephants, spotted hyenas, buffalo, and lions pose significant threats to human security. Venomous snakes and leopards are also safety concerns, but to a lesser degree. The anthropological dimensions of these threats to physical safety are underrepresented in the literature on human-wildlife conflict. This paper spotlights three recent incidents of people being killed by wildlife (elephant, hyena, and lion) in the area, and the psychosocial consequences that have since rippled across local communities. People expressed feelings of fear, resentment, anger, grief, and insecurity born of their experiences coexisting with large nondomestic mammals. Wildlife attacks on people engender material and emotional impacts with traumatic aftereffects. These human dimensions of wildlife are significant for equity reasons in and of themselves, and also for environmental sustainability as they affect people's tolerance for living with wildlife. Greater attention to the lived experiences of local people is needed to improve conservation practice in northern Tanzania.

Raycraft, Justin (2023). Wildlife and human safety in the Tarangire ecosystem, Tanzania. *Trees, Forests and People*, 13 (2023): 100418.
https://doi.org/10.1016/j.tfp.2023.100418

Modern Wildlife Monitoring Technologies Conservationists versus Communities? A Case Study The Terai-Arc Landscape, Nepal

The use of new and advanced wildlife monitoring technologies is shifting the paradigm of wildlife conservation and management. These digital technologies are helping wildlife conservationists and researchers around the world to monitor and manage wildlife with more precision and efficiency. However, this research study highlights some of the key drawbacks of using such modern technologies for wildlife conservation and management especially in developing countries, where the digital divide often clearly separates well-endowed conservation organisations and rural communities. It provides an insight into how the extensive use of such digital wildlife monitoring technologies can often marginalise the role of local and indigenous communities in wildlife management. Our case study, which was conducted in the Terai Arc Landscape (TAL) in southern Nepal, includes interviews with several wildlife experts, biologists, and members of local and indigenous communities. Findings indicate that the increasing militarisation and centralisation of protected area management, and the lack of universal access to the information gathered using modern monitoring technologies, have notably led to the marginalisation of local and indigenous communities in the region. These developments not only undermine the benefits of using such technologies but have also caused a rift between conservation organisations and local communities. As a result, this research study recommends that conservation organisations who advocate for the use of such technologies need to hold consultations and dialogues between conservationists and local and indigenous community members in order to be more inclusive and allow for a cross cultural and an interdisciplinary understanding of the best practices for the conservation and management of wildlife.

Shrestha, Yashaswi & Lapeyre, Renaud (2018). Modern Wildlife Monitoring Technologies Conservationists versus Communities? A Case Study The Terai-Arc Landscape, Nepal. *Conservation and Society*, 16(1): 91-101.
DOI: 10.4103/cs.cs_16_83

Artificial intelligence in wildlife conservation

Wildlife conservation is a critical issue that concerns the protection of endangered species and their habitats. However, the challenges facing conservationists are numerous and complex. For instance, monitoring the movements and behaviours of animals in their natural habitats can be challenging and time-consuming, particularly for species that are nocturnal or elusive. Moreover, poaching, illegal trade, habitat loss, and climate change are all significant threats to wildlife populations. Artificial intelligence can help to overcome some of these challenges and provide significant advantages for conservationists. One of the most significant advantages is the ability to process and analyse large amounts of data quickly and accurately. AI can analyse data from remote cameras and sensors, detecting patterns that may be difficult for humans to detect. This technology can also be used to identify endangered species, monitor their movements, and even predict their behaviour. For example, the Snow Leopard Trust has used AI technology to identify individual snow leopards by their spots, a technique that was previously impossible with manual identification. The organization has also used AI to predict the likelihood of snow leopards living in certain areas based on environmental factors. There are several examples of how AI is being used in wildlife conservation. One of the most well-known examples is the TrailGuard AI system, developed by the organization Resolve. TrailGuard AI uses motion sensors and cameras to detect poachers in protected areas and alerts rangers in real-time. The

system has been successful in reducing poaching incidents and helping to protect endangered species. Another example is the use of AI by the National Oceanic and Atmospheric Association (Noaa) which partnered with Google AI for Social Good's bioacoustics team to create an ML model that could recognise whale songs and monitor them in the ocean. MapBiomas water project, Brazil used AI and machine learning for processing more than 150,000 images generated by Nasa's Landsat 5, 7 and 8 satellites from 1985 to 2020 across the 8.5m sq km of Brazilian territory to track the water loss in this area. The organization has used AI to analyse thousands of hours of underwater recordings, detecting the sounds made by different whale species and identifying their locations. Despite the significant advantages of AI in wildlife conservation, there are also challenges and limitations that need to be addressed. One of the primary challenges is the cost of implementing AI systems. The technology can be expensive, and many conservation organizations may not have the resources to invest in it. Another challenge is the potential for AI to replace human involvement in conservation efforts. While AI can provide valuable data and insights, it is important to recognize that conservation is ultimately a human-driven endeavour that requires collaboration between experts, policymakers, and local communities.

Mishra, Arun Kumar (2023). Artificial intelligence in wildlife conservation. *International Journal of Avian & Wildlife Biology*, 7(2): 67.
DOI: 10.15406/ijawb.2023.07.00192

Safeguarding imperiled biodiversity and evolutionary processes in the Wallacea center of endemism

Wallacea the meeting point between the Asian and Australian fauna is one of the world's largest centers of endemism. Twenty-three million years of complex geological history have given rise to a living laboratory for the study of evolution and biodiversity, highly vulnerable to anthropogenic pressures. In the present article, we review the historic and contemporary processes shaping Wallacea's biodiversity and explore ways to conserve its unique ecosystems. Although remoteness has spared many Wallacean islands from the severe overexploitation that characterizes many tropical regions, industrial-scale expansion of agriculture, mining, aquaculture and fisheries is damaging terrestrial and aquatic ecosystems, denuding endemics from communities, and threatening a long-term legacy of impoverished human populations. An impending biodiversity catastrophe demands collaborative actions to improve community-based management, minimize environmental impacts, monitor threatened species, and reduce wildlife trade. Securing a positive future for Wallacea's imperiled ecosystems requires a fundamental shift away from managing marine and terrestrial realms independently.

Struebig, Matthew J. et al. (2022). Safeguarding imperiled biodiversity and evolutionary processes in the Wallacea center of endemism. *BioScience*, Vol. XX No. XX.
https://www.researchgate.net/publication/364750065_Safeguarding_Imperiled_Biodiversity_and_Evolutionary_Processes_in_the_Wallacea_Center_of_Endemism#fullTextFileContent

Rainforest conversion to smallholder cash crops leads to varying declines of beetles (Coleoptera) on Sumatra

Southeast Asian arthropod biodiversity is in rapid decline, but the variability of re- sponses within taxa has received little attention. Using canopy fogging, we collected ~50,000 beetles (Coleoptera) in (1) lowland rainforest, (2) jungle rubber (rubber agroforest), and smallholder monoculture plantations of (3) rubber and (4) oil palm in Sumatra, across two landscapes and seasons. On average, beetle abundance was more than 50%, and biomass over 75%, lower in rubber and oil palm plantations than in rainforest and jungle rubber. This pattern was influenced by landscape and season. Abundance and biomass declines were similar in Chrysomelidae, Elateridae, and Staphylinidae, but differed in Curculionidae, which were most abundant in oil palm due to the introduced oil palm pollinator *Elaeidobius kamerunicus*. Across beetle families, species richness in monocultures was reduced by at least 70% compared to rain- forest, with beetle richness in jungle rubber being similar to rainforest. Community composition in oil palm plantations differed markedly from the other land use systems for Chrysomelidae and Curculionidae, but less for Elateridae and Staphylinidae. Turnover contributed more to overall beta diversity than nestedness for all families and land-use systems. Likely undersampling of the beetle community in rainforest suggests that declines of beetle density and diversity are much more severe than reported here, especially for beetle families with many concealed species, such as Staphylinidae. This study provides first evidence that negative responses of beetles to tropical land-use change vary among families, and is the first report of its kind from heavily understudied Sumatra.

Kasmiatun et al. (2022). Rainforest conversion to smallholder cash crops leads to varying declines of beetles (Coleoptera) on Sumatra. *Biotropica*, 00:1-13.
https://onlinelibrary.wiley.com/doi/full/10.1111/btp.13165

Sumatra-wide assessment of spatiotemporal niche partitioning among small carnivore species

Niche partitioning is a result of interspecific competition between closely related species to allow coexistence. Multiple species of small carnivores co-occur throughout their ranges in Sumatra, but they are among the lesser studied group of mammal species. This study aimed to collate occurrence records of small carnivores, model their island-wide spatial distribution, and assess their spatiotemporal niche partitioning in Sumatra. We collated camera trap records of small carnivores that were mainly bycatch data from widespread tiger surveys. We used Maxent to predict suitable habitat for nine small carnivore species in response to environmental variables, calculated pairwise spatial niche overlap, and then assessed temporal overlap using Kernel density estimation. In total, we detected 16 of the 21 small carnivore species known to occur in Sumatra. We predicted the suitable habitat of nine species that were found in ≥ 20 locations. Species with the smallest extent of predicted suitable habitat were the Malay civet (*Viverra tangalunga*) and short tailed mongoose (*Herpestes brachyurus*). Of 36 pairwise comparisons, ve species pairs had high overlaps and four species pairs had low overlap on spatiotemporal niche. High overlaps did not necessarily indicate high competition pressure because these species have di erent behaviour to allow coexistence, such as food preference and arboreality. Camera trap surveys are commonly conducted for species specic studies, yet they also yield abundant records of non target species. We therefore encouraged collaboration among institutions working in the same region to use bycatch data to ll the knowledge gaps in the ecology of other lesser known species.

Sibarani, Marsya C. et al. (2022). Sumatra-wide assessment of spatiotemporal niche partitioning among small carnivore species. *Mammalian Biology*, s42991-022-00315-6
https://link.springer.com/article/10.1007/s42991-022-00315-6#citeas

Drivers of three most charismatic mammalian species distribution across a multiple-use tropical forest landscape of Sumatra, Indonesia

Tropical Rainforest Heritage sites of Sumatra are some of the most irreplaceable landscapes in the world for biodiversity conservation. These landscapes harbor many endangered Asiatic mammals all suffering multifaceted threats due to anthropogenic activities. Three charismatic mammals in Sumatra: *Elephas maximus sumatranus*, *Pongo abelii*, and *Panthera tigris sumatrae* are protected and listed as Critically Endangered (CR) within the IUCN Red List. Nevertheless, their current geographic distribution remains unclear, and the impact of environmental factors on these species are mostly unknown. This study predicts the potential range of those species on the island of Sumatra using anthropogenic, biophysical, topographic, and climatic parameters based on the ensemble machine learning algorithms. We also investigated the effects of habitat loss from current land use, ecosystem availability, and importance of Indonesian protected areas. Our predictive model had relatively excellent performance (Sørensen: 0.81–0.94) and can enhance knowledge on the current species distributions. The most critical environmental predictors for the distribution of the three species are conservation status and temperature seasonality. This study revealed that more than half of the species distributions occurred in non-protected areas, with proportional coverage being 83%, 72%, and 54% for *E.m. sumatranus*, *P. abelii*, and *P.t. sumatrae*, respectively. Our study further provides reliable information on places where conservation efforts must be prioritized, both inside and outside of the protected area networks, to safeguard the ongoing survival of these Indonesian large charismatic mammals.

Rahman, Dede A. et al. (2022). Drivers of three most charismatic mammalian species distribution across a multiple-use tropical forest landscape of Sumatra, Indonesia . *Animals*, 12: 2722.
https://www.mdpi.com/2076-2615/12/19/2722

Empirically grounded technology forecasts and the energy transition

Rapidly decarbonizing the global energy system is critical for addressing climate change, but concerns about costs have been a barrier to im- plementation. Most energy economy models have historically underestimated deployment rates for renewable energy technologies and overestimated their costs. These issues have driven calls for alternative approaches and more reliable technology forecasting methods. Here, we use an approach based on probabilistic cost forecasting methods that have been statistically validated by backtesting on more than 50 technologies. We generate probabilistic cost forecasts for solar energy, wind energy, batteries, and electrolyzers, conditional on deployment. We use these methods to estimate future energy system costs and explore how technology cost uncertainty propagates through to system costs in three different scenarios. Compared to continuing with a fossil fuel-based system, a rapid green energy transition will likely result in overall net savings of many trillions of dollars even without accounting for climate damages or co-benefits of climate policy.

Way, Rupert et al. (2022). Empirically grounded technology forecasts and the energy transition. *Joule*, 6(9): 2057-2082.
https://www.sciencedirect.com/science/article/pii/S2542435122004 10X

EVENTS

UN Climate Change Conference 2023 (UNFCCC COP 28) - Dubai, UAE 30 December-12 December 2023

COP 28 will take place from 30 November until 12 December 2023. Dates for the pre-sessionals will be announced. Please use the navigation above to find information about the conference. Advance logistical information is contained in the Information for Participants section. Also please consult the notifications to Parties and Observers page regularly for advance official communications to participants.

New! Opening of Media accreditation

Media accreditation for COP28 is now open. For more information on media accreditation for COP28 visit the dedicated FAQ page.

Updates from the COP 28 Presidency

The Road to the UAE

The COP 27 Presidency and the Incoming COP 28 Presidency are committed to ensuring a transparent and inclusive process in the lead-up to COP 28.

Visit the Road to the UAE page to find more information about how they intend to engage Parties throughout the year.

New! COP 28 UAE Thematic Program

Throughout the Dubai conference, the incoming COP 28 Presidency will hold open consultations on thematic areas and sequencing, inviting inputs from the broad mix of stakeholders that will attend the conference.

View the COP 28 UAE thematic program

The International Symposium on Wildlife Biodiversity Conservation 2023 (ISWBC 2023) – Yogyakarta, 4-6 September 2023

Are you passionate about wildlife conservation and have groundbreaking research, insightful case studies, or compelling perspectives to share? We invite you to submit your abstracts for the International Symposium on Biodiversity Wildlife Conservation. This is your chance to be a part of a diverse and global community dedicated to protecting our planet's precious flora and fauna. Whether you specialize in biodiversity preservation, climate change impacts, indigenous knowledge, or collaborative strategies, we want to hear from you! Selected abstracts will have the opportunity to present their work in front of an esteemed audience of international conservation leaders and make a lasting impact on the future of wildlife conservation.

a. About

All the accepted papers will be submitted for possible inclusion in indexed and high-impact journals. Submission of an abstract to the symposium implies that it has not been submitted elsewhere. **We kindly provide full support*) for 40-50 high-quality selected abstracts/papers to be published in the reputable International Journals**. Here we summarize the list of objective journals as follows**):

- Biodiversitas Journal of Biological Diversity (https://smujo.id/biodiv)
- Journal of Tropical Biodiversity and Biotechnology (https://jurnal.ugm.ac.id/jtbb)
- Jurnal Ilmu Kehutanan (https://jurnal.ugm.ac.id/jikfkt)
- Taprobanica The Journal of Asian Biodiversity (http://www.taprobanica.org/)
- HAYATI Journal of Biosciences (https://journal.ipb.ac.id/index.php/hayati or https://www.journalofbiosciences.org/)

Important dates:
Abstract submission deadline on **August 25th 2023**
Notification of abstract acceptance on **August 27th 2023**
Full paper submission deadline on **September 1st 2023**

The final draft will be submitted to the publisher after the ISWBC activity. Selected papers or manuscripts that have been submitted to the destination journal will be published depending on the length of the review process by the publisher. Furthermore, the correspondence process is carried out between the author and the publisher respectively.

b. Author Guidelines

- The abstract topic should conform to the scope of the conference/symposium and publisher.
- The submitted abstract must be original work and should not have been previously published or presented elsewhere.
- All manuscripts must be written in English and must be prepared on A4 Size (single column, double spacing), with 1-inch margins in Microsoft Word document file format (.docx), typed with Times New Roman font size 11 pt.

The abstract must be prepared in English and contain the following sections:

- Introduction / Background / Justification
- Objective(s)/Hypothesis(es)
- Methods

- Results
- Implications/Conclusions

c. Peer-Review

The submitted papers will be peer-reviewed based on relevance and timeliness, technical content and scientific rigor, novelty and originality, and their quality of presentation. All the submitted abstracts will be peer-reviewed by an expert panel, and the selected full manuscript will be submitted to suitable journals. All submitted manuscripts are peer-reviewed by the editorial boards of each journal.

d. Publication Ethics

- **Authorship and contributorship:** Contributors are either author contributors or non-author contributors. Non-author contributors are those who helped in carrying out the research and they can be appreciated at the acknowledgements statement at the end of the paper.
- **Policy on intellectual property:** The author must take the responsibility of their results, data, figures in the submitted manuscript have not been published elsewhere, nor are they under consideration (from you or one of your contributing authors) by another publisher. This policy ensures that contributors who have made substantive intellectual contributions to an article are given credit and that contributors understand their role in taking responsibility and being accountable for what is published.

Join SER in Darwin, Australia September 26-30, 2023 for our 10th World Conference on Ecological Restoration

Since 2005, the SER World Conference has been the premier venue for those interested in connecting with the international restoration community. Our World Conferences are an exciting biennial gathering of experts in the scientific, technical, and socio-economic dimensions of restoring damaged and degraded ecosystems all biomes and on all continents. Conference attendees are passionate about discussing and debating big picture issues and broad trends, as well as specific tools, techniques, research, and policies for restoration.

We are proud to host our next World Conference in Darwin, Australia September 26-30, 2023. SER2023 will be the Society's 10th World Conference since 2005 and 26th meeting since our founding in 1988.

The SER World Conference brings delegates from every continent representing a range of professional backgrounds including natural and social sciences, environmental engineering, urban and regional planning, public policy, landscape architecture, natural resource management, and more. Attendees include:

- Professors, researchers, and students
- Staff scientists from research institutes and governmental agencies specializing in restoration, conservation, and land management
- Environmental consultants and contractors ranging from independently owned small business to national and multinational companies
- Local, national, and international nonprofit organizations
- Staff from botanic gardens, zoos, engineering and landscape firms, and mining and extraction industries
- Individuals and entities from the financial sector
- We always feature *Make a Difference* field trips as part of the conference program, giving participants a chance to learn about local management challenges and have hands-on participation in restoration implementation.
- Our conferences are hosted around the world to highlight the diverse landscapes our community work in and facilitate the exchange of knowledge among our global network of over 4,000 members. We hope to see you soon!

About the International Congress for Conservation Biology

SCB's 31st International Congress for Conservation Biology (ICCB 2023) will take place from July 23-27, 2023 in Kigali Rwanda.

ICCB is the premier global meeting for conservation scientists and professionals, including researchers, students, agency personnel, environmental educators, practitioners, and other conservation stakeholders. Attendees gather for lively discussions and scientific presentations on the nexus between biodiversity conservation and genetics, ecology, biogeography, anthropology, history, psychology, economics, conservation marketing, religion, and more.

InJAST
Volume 4, Number 1, April 2023
Pages: 10-21

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.7283

Evaluation of government funding support for national priority development related to the environmental sector in regions

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Submitted 8 March 2023; Accepted 24 April 2023

ABSTRACT

Sustainable development focusing on environmental issues is the target of both central and local governments. Ideally, planning and funding this issue requires harmonizing and implementing top-down and bottom-up alignment. Neglect from a regional point of view often causes various obstacles in implementation, which of course, causes inefficiency. The allocation and distribution of budgeting through special transfer funds for environmental issues are interesting to elaborate with attention to the sustainability of the policy and the expected benefits. The analysis of the implementation of government funding support for the development of national priorities related to the environmental sector in the region is interesting to be elaborated more deeply to provide information on strategic control and integration of future development. This further elaboration is in line with the national economic recovery after the COVID-19 pandemic, which has attracted the attention of many parties. The method used in the analysis is a qualitative approach through literature review and limited discussion (FGD) with stakeholders at the central-regional level and through online survey methods. The literature review uses previous research, journals, books, and planning documents at the central and regional levels to capture the Physical SAF 2021 policy for the environment, analyze budget distribution, and analyze central-regional planning/funding alignment in terms of planning documents. Focus Group Discussion (FGD) method and online questionnaires are used to capture field problems. Expectations desired in this evaluation-based analysis can provide recommendations following the actual conditions in the area as the implementer of this fund.

ABSTRAK

Pembangunan berkelanjutan yang berfokus pada isu lingkungan menjadi target pemerintah baik pusat maupun daerah. Idealnya, perencanaan dan pendanaan masalah ini membutuhkan harmonisasi dan implementasi top-down dan bottom-up. Pengabaian dari sudut pandang daerah seringkali menimbulkan berbagai kendala dalam pelaksanaannya, yang tentunya menimbulkan inefisiensi. Alokasi dan distribusi penganggaran melalui dana transfer khusus untuk masalah lingkungan hidup menarik untuk dijabarkan dengan memperhatikan kesinambungan kebijakan dan manfaat yang diharapkan. Analisis pelaksanaan dukungan pendanaan pemerintah untuk pembangunan prioritas nasional terkait bidang lingkungan hidup di daerah menarik untuk dielaborasi lebih dalam guna memberikan informasi pengendalian strategis dan keterpaduan pembangunan ke depan. Penjelasan lebih lanjut ini sejalan dengan pemulihan ekonomi nasional pasca pandemi COVID-19 yang menjadi perhatian banyak pihak. Metode yang digunakan dalam analisis adalah pendekatan kualitatif melalui kajian pustaka dan diskusi terbatas (FGD) dengan pemangku kepentingan di tingkat pusat dan daerah serta melalui metode survei online. Tinjauan literatur menggunakan penelitian sebelumnya, jurnal, buku, dan dokumen perencanaan di tingkat pusat dan daerah untuk menangkap kebijakan SAF Fisik 2021 untuk lingkungan, menganalisis distribusi anggaran, dan menganalisis keselarasan perencanaan/pembiayaan pusat-daerah dalam hal dokumen perencanaan. Metode Focus Group Discussion (FGD) dan kuesioner online digunakan untuk menjaring permasalahan lapangan. Harapan yang diinginkan dalam analisis berbasis evaluasi ini dapat memberikan rekomendasi sesuai dengan kondisi aktual di daerah selaku pelaksana dana ini.

Keywords: *environment, planning, regional development, Special Allocation Fund/SAF*

INTRODUCTION

In the last few decades, environmental issues have become one of the mainstays of development nationally and regionally. Attention to the environment is a form of human ecological awareness that is starting to shift from meeting short-term needs to sustainable development (Al-Qudah et al., 2021; Castro, 2004). The essence of sustainable development is the internalization of the impact of every social and economic activity on the environment, meaning that every social and economic activity needs to avoid/prevent or consider its impact on environmental conditions. Increasing population growth has the consequence of a fast and instant revolution in fulfilling economic needs; on the other hand, there are side effects related to the environment (Pambudi, 2020a;

Pambudi, 2019; Common & Stagl, 2005). For example, the conversion of an area in forest land is a result of population pressure on the land, indicating that there is a role for the community, both on a specific scale and in general, which affects the condition of the sustainability of natural resources (Watson et al. 2014, Cumming 2016, Mtibaa et al. 2018). Population pressure on this land is driven by an imbalance between the rate of population growth and the availability of land, resulting in increased activity and intensity on existing land or opening up new land (Soemarwoto, 1999). Conversion without regard to topographical, geological, and ecosystem carrying capacity conditions causes natural disasters such as pollution, landslides, floods, and droughts (Sinukaban, 2007).

The development of the environmental sector is not only the responsibility of the central government but also of regional governments in the provinces and districts. Generally, there are two environmental policies: a) conservation and management of natural resources; b) control of environmental damage and pollution. The central and regional governments implement various physical and non-physical policies to regulate and mitigate environmental damage and pollution. In the context of development funding, the central government's special attention to the regions is manifested through a transfer fund mechanism with physical and non-physical Special Allocation Fund (SAF) menus in the environmental sector. Transfer funds to the regions reflect the role of the central government, which functions to help economic growth in the areas (Fauziyah & Trisnawati, 2022). The transfer fund scheme to these regions has changed for simplification.

Special Transfer Funds are funds allocated in the State Budget to regions to help finance special activities, both physical and non-physical, which are regional affairs. The specific activities referred to are regional affairs following the division of functions in Law Number 23 of 2014 concerning Regional Government and following the National Priorities (PN) in the Government Work Plan. One of the transfer fund policies from the central government to the regions is SAF for the environment (GoI, 2020c; GoI, 2020d; Pambudi, 2020b). In 2021, the policy direction for SAF Physical Assignment of the Thematic Environment Sub-sector for Provision of Sustainable Economic Infrastructure was to control environmental pollution and protect and manage the environment, control ecosystem damage and waste management through waste reduction and handling, which are adjusted to conditions characteristic of each region that becomes their authority.

The Physical Special Allocation Fund for the Environment sub-sector will support national priorities for developing the environment, increasing disaster resilience and climate change through the Priority Programs for Improving Environmental Quality, Increasing Disaster and Climate Resilience, and Low Carbon Development. Specific Physical Allocation Fund Type of Assignment in the Environment and Forestry Sector, the Environment sub-sector, 2021 Fiscal Year supports the program for providing sustainable economic infrastructure, especially in the development of 10 priority tourist destinations to support economic recovery in the regions as an effort to deal with the impact of COVID-19 (GoI, 2021a; GoI, 2021b).

Development planning related to the national environment is also determined by regional development planning (Pambudi, 2021; Mina, 2016). An analysis of government funding support implementation for national priority development related to the environmental sector in regions is interesting to elaborate more deeply to provide strategic control information and future development synergies. This further elaboration is in line with the post-COVID-19 national economic recovery, which was a concern of many parties. The desired hope in this evaluation-based analysis is to be able to provide recommendations following the realistic conditions in the region as the executor of this budget in the field.

METHODS

An analysis of the implementation of government funding support for national priority development related to the environmental sector in the regions uses a qualitative approach through literature reviews and limited discussions (FGD) with stakeholders at central-regional levels and through online survey methods. The literature review uses previous research, journals, books, and planning documents at the central and regional levels to capture the 2021 Physical SAF policy for the Environment, analyze budget distribution, and analyze central-regional planning/funding collaboration from the planning documents side. To identify field problems, uses Focus Group Discussion (FGD) method, panel discussion, and online questionnaires. Questionnaire data was collected through the Google Form platform and addressed to the SAF Physical Assignment activity manager. The filling list is prepared according to issues in the environmental field. A questionnaire survey was conducted to see the extent to which SAF implementation governance problems were related to various aspects, including institutional, regulatory, budgetary, and implementation technical aspects. This survey was also to obtain input from SAF implementers throughout Indonesia in provinces, districts, and cities. The questionnaire in the Google Form application contains a list of fundamental questions as survey material, including a) Conformity of Physical SAF activities with regional priorities; and b) Obstacles to SAF implementation from institutional, regulatory, and funding aspects. This analysis identifies substantial obstacles in the field as one of the

considerations for recommending SAF improvements related to the Environment.

RESULT AND DISCUSSION

Literature Review of Environmental Development Policy through SAF 2021

Thematic Physical Special Allocation Fund for Provision of Sustainable Economic Infrastructure in the Environment Sub-sector has the goal of increasing Environmental Quality as reflected in the Environmental Quality Index (EQI) score of 67.33 in 2021 to increase the achievement of reducing waste in the regions by 24 percent and improving waste handling by 74 percent. It is to achieve the target of the National Policy and Strategy for Household Waste Management and Household Waste-like Waste (Jakstranas) to provide sustainable economic infrastructure, especially in developing 10 (ten) priority tourist destinations.

Table 1. Sampling time for seawater quality and phytoplankton.

Activities Menu	Activities Details
Waste management and supporting infrastructure	• Development of a Master Garbage Bank (BSI) with a capacity of 3 tons/day • Construction of a compost house with a capacity of 1 ton/day • Construction of a Biodigester with a capacity of 1 ton/day • Provision of hydraulic press machine • Provision of an organic chopping machine • Provision of three-wheeled motorbike garbage transportation equipment • Provision of waste sorting carts • Provision of dump trucks for transporting garbage • Provision of arm roll garbage transportation equipment • Construction of a Recycling Cente with a capacity of 10 tons/day • Procurement of garbage containers (arm roll trucks)

Source: GoI, 2020d

Physical Special Allocation Funds Thematic Assignments Provision of Sustainable Economic Infrastructure for the 2021 Fiscal Year has location criteria including 1) Represents a Regency/City that has compiled and determined (has been approved by the Regional Head) Regional Policies and Strategies for the Management of Household Waste and Household-like Waste Waste (Jakstrada) and Waste Management Balance Sheet; 2) Is a Regency/city that is included in the priority tourist destination area; 3) Regencies/cities that have adequate commitment and progress in waste management, but the percentage of operational capacity for waste management is still low; and 4) PON Papua 2021 venue based on the Instruction of the President of the Republic of Indonesia 1 of 2020 concerning the Acceleration of Support for the Implementation of the XX National Sports Week and the 2020 XVI National Paralympic Week in Papua Province.

Physical SAF Activities Types of Assignments for the Environment Sub-sector are carried out by referring to the procedures listed in the Operational Guidelines stipulated by the Minister who administers government affairs in the Environment Sector. Physical SAF activities for the Environment sub-sector, especially in waste management activities, have special provisions, including the construction of a central waste bank, compost house, biodigester, and recycling center and their supporting facilities, which must fulfill the following requirements: a) Procured with intact components/not separated to construct buildings and their infrastructure; b) Land/land from the local government or community grants and free from disputes; c) Considering an effective form of waste management because the characteristics of the waste and the character of society will differ from one region to another; d) Considering household expenses, collection expenses, and environmentally friendly.

The 2021 Physical Special Allocation Fund for the Assignment of the Environment Sub-sector can support the achievement of the sixth National Priority: building the environment, increasing disaster resilience, and climate change. In this regard, several target outcomes are to be achieved, namely increasing the quality of the environment as reflected in the increasing score of the Environmental Quality Index (EQI) of 67.33. Physical Special Allocation Fund for Environment Sub-Sector Output Targets: 1) Establishment of an Early Warning System (EWS) for environmental disaster control by providing information on water quality and mercury to the public in the framework of pollution control and stunting reduction; 2) Increasing the achievement of reducing waste in the regions to achieve the target of the Regional Policy and Strategy for the Management of Household Waste and Household-like Waste (Jakstrada) in 2021; and 3) Improved waste handling to achieve the Jakstrada target in 2021.

The criteria for a locus of Physical SAF for the Environment Sub-Sector in 2021 include: 1) Regencies/Cities that have compiled and established (approved by the Regional Head) Regional Policies and Strategies for the Management of Household Waste and Household-like Waste (Jakstrada) and balance sheets waste management; 2) Regencies/cities that include the following characteristics: a) Locus of handling stunting; b) Areas of 10 priority tourist destinations; c) The 2021 National Sports Week in Papua venue is based on the Instruction of the President of the Republic of Indonesia 1 of 2020 concerning the Acceleration of Support for the Implementation of the XX National Sports Week and the 2020 XVI National Paralympic Week in Papua

Figure 1. Distribution of Locations for Special Allocation Fund Implementation in Fiscal Year 2021 for the Environment Sub-Sector

Province; and d) Regencies/cities that have good commitment and progress in waste management, but the percentage of operational capacity for waste management is still low. Locus criteria for the ONLIMO menu and lab tools, including 1) Prov/District/City, which is the locus of villages for handling stunting; 2) Prov/District/City in 15 Priority River Basin Areas, 15 Priority Lakes, and heavily polluted rivers; 3) Prov/District/City which is the locus of the action plan for handling mercury according to Minister of Environment and Forestry Regulation 81 of 2019; and 4) Prov/District/City which has an operational and accredited environmental laboratory or proficiency test.

In 2021, the total budget allocation for SAF for the Physical Assignment of the Environment Sub-sector was IDR332,115,835,600.00 (GoI, 2020a). This budget is distributed to 29 Provinces and 93 Regencies/Cities, or only 4.65 percent compared to the budget ceiling for the Environment sector in BA.029 Ministry of Environment and Forestry. Based on the online reporting https://monevdak.menlhk.id, realizing the Physical SAF budget for the Environmental Sub-sector in Fiscal Year 2021 until the 21st of June 2021 is 0.09 percent or IDR291,700,000.00 of the total ceiling. This achievement is still very small considering the implementation of activities has entered the third quarter.

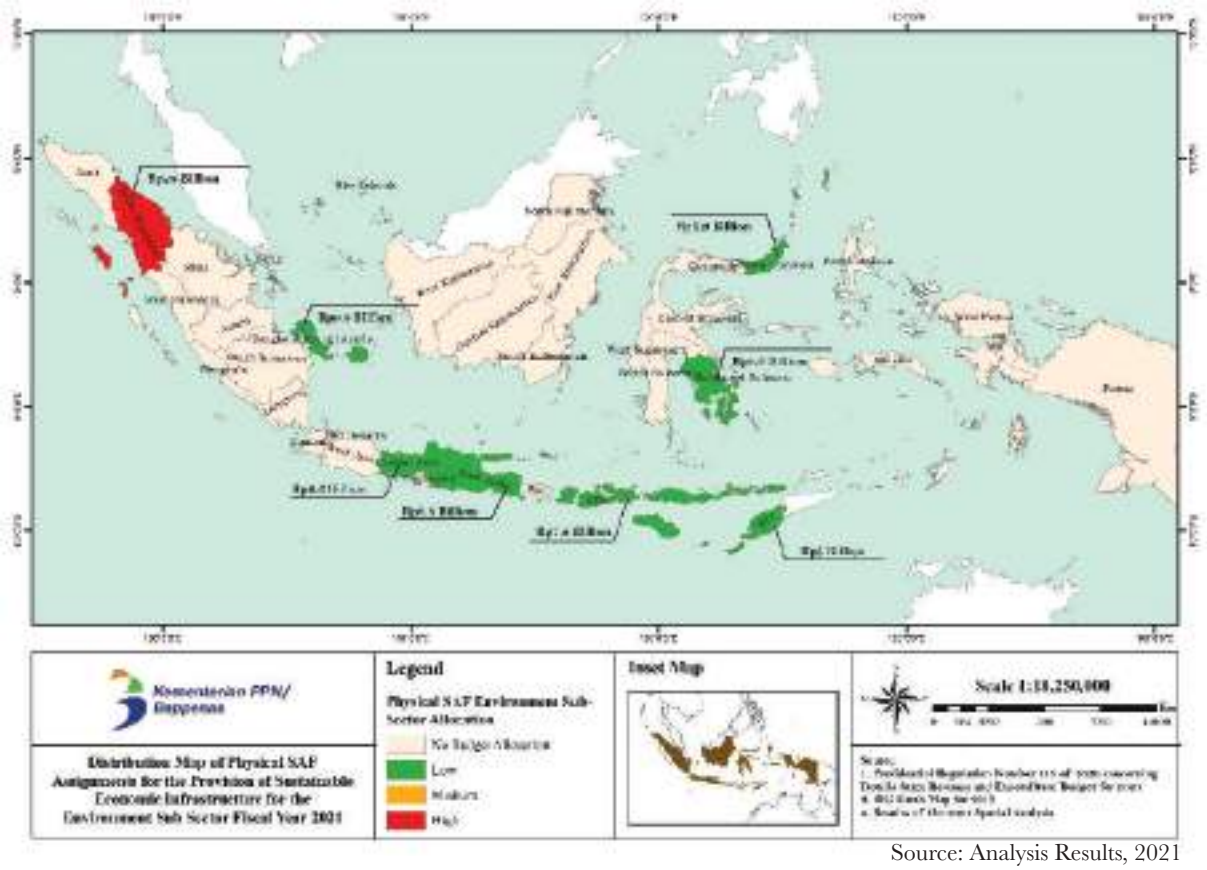
Activities in support of water quality monitoring equipment (EWS and ONLIMO) are available again on the Physical SAF menu of the Environment Sub-sector for 2021. Based on the Joint Monev SAF activities carried out by the Ministry of PPN/Bappenas in 2019, outcomes that support the increase of the Environmental Quality Index (EQI) cannot be obtained directly through the strengthening of tools for monitoring water quality data. There needs to be an activity menu intervention that can have a direct impact on improving the environment so that it can increase the EQI value. From a discussion with Ministries/Agencies and the Ministry of National Development Planning/Bappenas in June 2021, the Planning Bureau of the Ministry of Environment and Forestry clarified that support for EQI achievements from EWS and ONLIMO could not be seen directly. However, ONLIMO is a means of obtaining more accurate data when compared to manual water quality measurements. Water quality monitoring activities require many sample points so that to monitor continuously, ONLIMO (online monitoring) can help facilitate data provision. Online Monitoring (ONLIMO) is one of the pre-preparatory conditions for monitoring data in real-time relating to pollution conditions as a basis for policy-making.

Evaluation of the Distribution of the Physical SAF Budget Assignment to Provision of Sustainable Economic Infrastructure for the 2021 Fiscal Year of the Environment Sub-sector

The Special Allocation Fund (SAF) for Physical Thematic Assignments for the Provision of Sustainable Economic Infrastructure (PSEI) for the Environment Sub-Sector has a total budget of IDR77,354,950,000.00 or 2.02 percent of the total SAF Physical Assignment of PSEI, and 0.22 percent of Physical SAF for FY 2021. A Map of the distribution of SAF Physical for Thematic Assignments of PSEI for the Environment Sub-sector for the Provincial Budget for FY 2021 is contained in Figure 6.19. Map of the distribution of the Physical Allocation Fund (SAF) budget for the PSEI Assignment of Environment Sub-sector for the 2021 Fiscal Year based on Presidential Regulation 113 of 2020 concerning Details of the 2021 State Revenue and Expenditure Budget. The SAF Physical Assignment PSEI Budget for the Environment Sub-sector mapped is an allocation accumulated at the provincial level and districts/cities. The results of the analysis show that as many as 26 regions do not have a Physical SAF Assignment PSEI of Environment Sub-sector 2021 budget, seven regions are in the low category (green zone with an allocation of 4-12 billion rupiahs), no areas in the medium classification (orange zone with 12-20 billion rupiahs allocation), and one region in the high category (red zone with 20-28 billion rupiahs allocation).

Based on the distribution map above, regional governments with large SAF budgets for the Environment sub-sector can be seen from 2 sides: the high central government support or the high dependence of the region concerned. Based on the results of discussions with the Regional Government of North Sumatra, which is in the red category, information is obtained that environmental quality is one of the strategic issues on the development agenda of North Sumatra Province. The existence of an interest in the utilization of natural resources creates pressure on environmental quality, pollution, and other environmental damage. North Sumatra Province is building and developing a sustainable development model through green growth to ensure a balance between economic development and environmental quality, especially since North Sumatra has two Major Projects as centers of economic growth, namely SEZ Sei Mangkei and Lake Toba KSPN.

Based on monitoring the value of the Environmental Quality Index (EQI), Sumatra Province, in the last 5 (five) years, has an EQI score improving from 50.32 percent in 2015 to 69.37 percent in 2020. It shows an improvement in the quality environment in North Sumatra Province during the last 5 (five) years. The achievement of increasing the EQI value of North



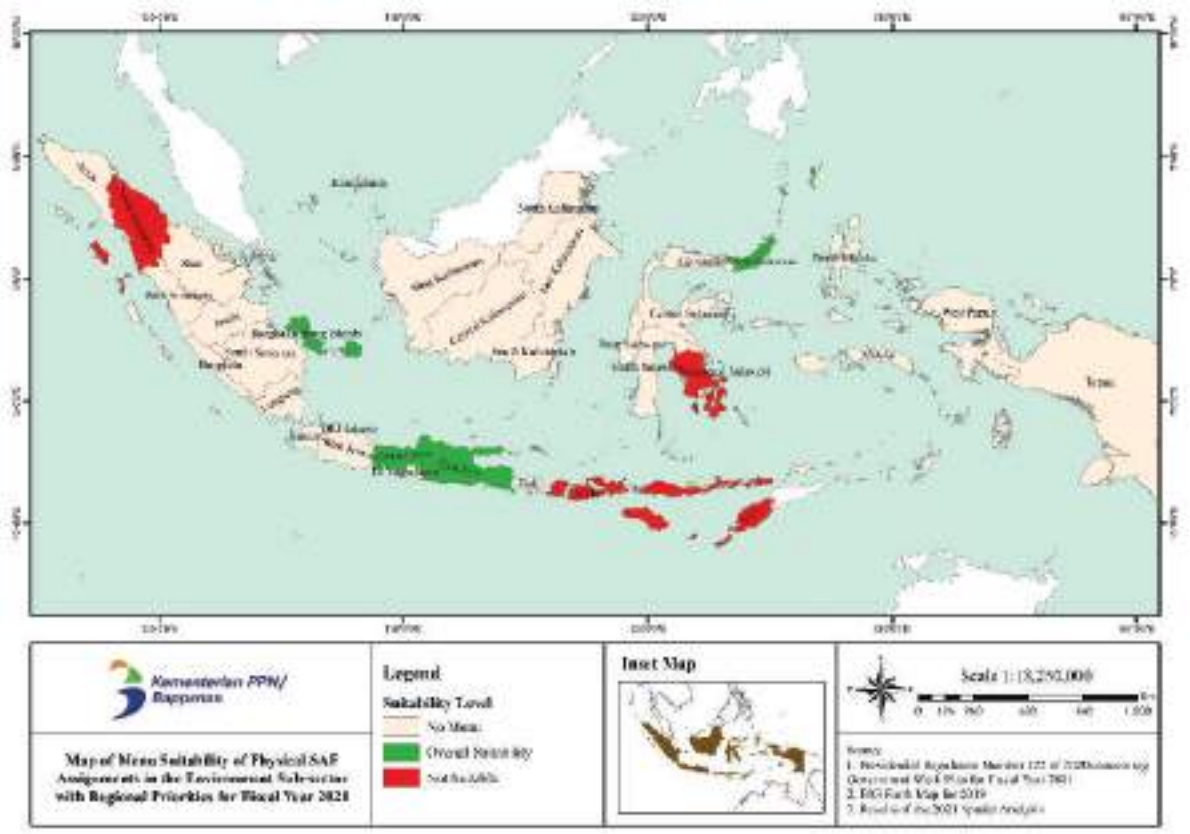
Source: Analysis Results, 2021

Figure 2. Distribution of Locations for Special Allocation Fund Implementation in Fiscal Year 2021 for the Environment Sub-Sector

Sumatra cannot be separated from the support of the Environmental Sub Sector activity program. So far, the contribution of SAF Physical activities for the Environment sub-sector to the regions is still relatively high. As happened in Dairi Regency, in 2021, the contribution of the SAF budget for the Physical Assignment of the Environment Sub-sector reached IDR6,820,000,000.00 out of a total budget of IDR15,520,789,458.00 or in other words, the source of the regional environmental sector budget, amounted to 43.94 percent comes from the Physical SAF budget for the Environment Sub-Sector. Physical SAF activities for the Environment sub-sector have a variety of menus that can support the improvement of environmental quality in North Sumatra Province, specifically by reducing river pollution through strengthening waste handling infrastructure.

Evaluation of Regional Priority Synergies Related to the Environment with the Physical SAF Menu

Nationally, the 5-year development plan is written down into annual planning, which involves relations with regional planning in the planning process (Pambudi et al., 2022; GoI, 2020b). The Physical Special Allocation Fund for the Thematic Assignment for the Provision of Sustainable Economic Infrastructure (PSEI) in the Environmental Sub-sector only has 1 (one) activity menu, namely, waste management and supporting infrastructure. The criteria for the location of the Physical SAF Assignment for the Environment Sub-sector include 1) It is a Regency/City that has compiled and determined (already approved by the Regional Head) Regional Policies and Strategies for the



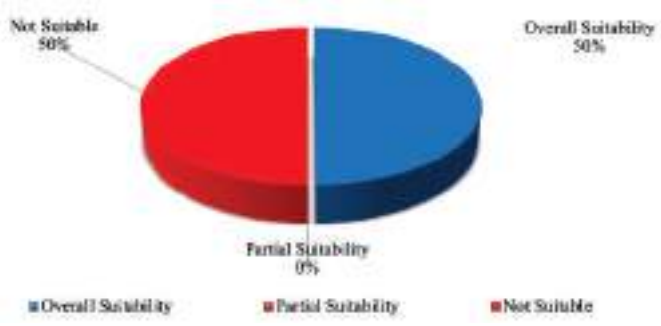
Source: Analysis Results, 2021

Figure 2. Distribution of Locations for Special Allocation Fund Implementation in Fiscal Year 2021 for the Environment Sub-Sector

Management of Household Waste and Waste Similar to Household Waste (Jakstrada) and a Waste Management Balance; 2) Is a regency/city includes as a priority tourist destination area; 3) Is a regency/city that has exemplary commitment and progress in waste management, but the percentage of operational capacity for waste management is still low; 4) The PON Papua 2021 venue based on the Instruction of the President of the Republic of Indonesia 1 of 2020 concerning Acceleration of Support for the Implementation of the XX National Sports Week and the XVI National Paralympic Week 2020 in Papua Province.

The Physical Special Allocation Fund (SAF) for the Sustainable Economic Infrastructure Provision (PSEI) Thematic Assignment in the Environment Sub-sector Fiscal Year 2021 is only allocated to regions in 8 (eight) provinces, including Bangka Belitung Province, Central Java, East Java, North Sulawesi, North Sumatera, Southeast Sulawesi, West Nusa Tenggara, and East Nusa Tenggara. Based on the planning gap analysis results in

the eight provinces, there are 4 (four) provinces where the regional priorities follow the Physical SAF menu, and there are 4 (four) provinces where the regional priorities are not following the Physical SAF menu. Four provinces with regional priorities relevant to the menu include the Provinces of the Bangka Belitung Islands, Central Java, East Java, and North Sulawesi.



Source: Analysis Results, 2021

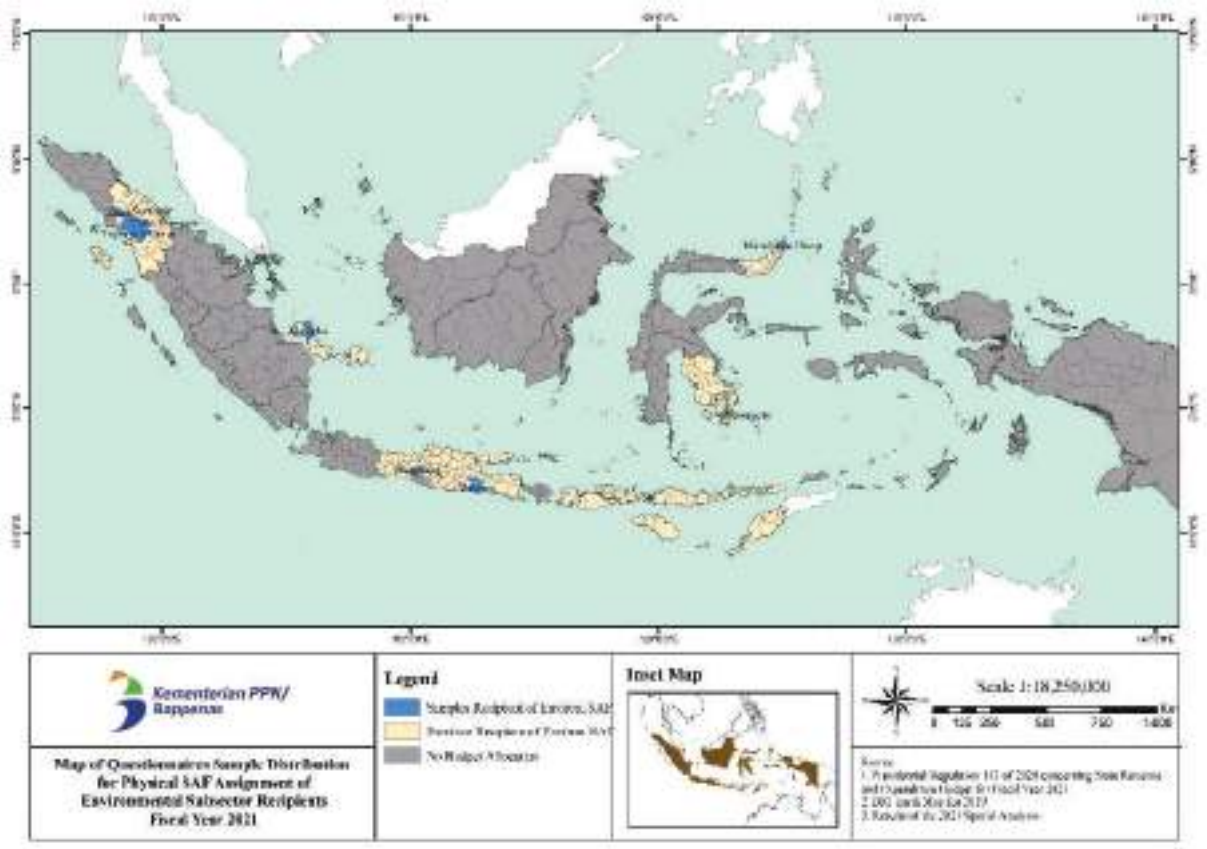
Figure 4. Level of Suitability of Physical SAF Assignments for the Environment Sub-sector with Regional Priorities Fiscal Year 2021

Meanwhile, 4 (four) other provinces do not have environmental priorities, including North Sumatra, Southeast Sulawesi, West Nusa Tenggara, and East Nusa Tenggara. Based on the data and analysis results, the proportion of regions with development priorities that are overall suitable with the SAF menu for the Thematic Assignment of PSEI for the Environment sub-sector is only 50 percent, and those that are not overall suitable are 50 percent.

Evaluation of Physical SAF Performance Problems in the Environment Sub-sector in the Regions Based on Questionnaire

A questionnaire survey shows the extent of SAF implementation governance problems related to various aspects, including institutional, regulatory, budgetary, and technical implementation. This survey was also conducted to obtain input from SAF implementers in provinces, districts, and cities throughout Indonesia. Questionnaires filled out by the local government via the Google form were verified through a Focus Group Discussion involving the central and local governments to ensure that the analysis results can be more accountable.

In 2021, there will be 101 regions consisting of 86 Provinces/Districts/Cities receiving Physical SAF Assignment of the Thematic Environment Sub-Sector for Reducing Stunting Rates and 15 Thematic Districts/Cities for Infrastructure Development for Sustainable Economic Development. Several regions (107 regions) have participated in the questionnaire survey for the implementation of the Physical SAF



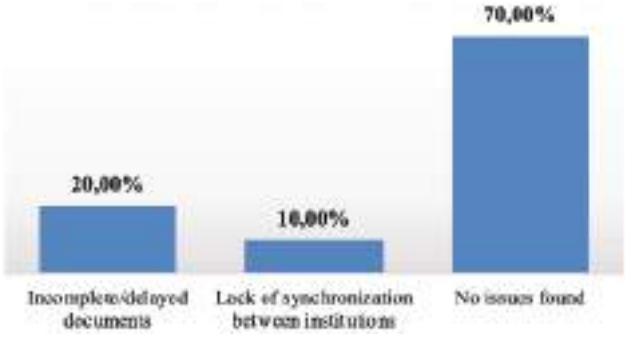
Source: Analysis Results, 2021

Figure 2. Distribution of Locations for Special Allocation Fund Implementation in Fiscal Year 2021 for the Environment Sub-Sector

Assignment of the Environment Sub-Sector in 2021, which are spread across 31 provinces, including the Provinces of Banten, Jambi, West Papua, Riau, West Java, West Sumatra, Central Kalimantan, South Sulawesi, Java East, North Sumatra, Babel Islands, North Sulawesi, West Kalimantan, East Kalimantan, Lampung Gorontalo, Central Sulawesi, East Nusa Tenggara, Aceh, Central Kalimantan, South Sumatra, Central Java, East Java, Bali, Southeast Sulawesi, North Maluku, Kalimantan South, D.I Yogyakarta, West Nusa Tenggara, Papua, and DKI Jakarta.

In this analysis, the incoming questionnaire data has been sorted according to the interests of the Thematic Locus for the Provision of Sustainable Economic Infrastructure. Based on the results of further disaggregation, of the 15 Regencies/Cities receiving Physical SAF Assignment Thematic of the Provision of Sustainable Economic Infrastructure (PSEI) for Environment Sub-sector in 2021, 11 respondents coming from 10 Regencies/Cities receiving Physical SAF for the thematic PSEI of Environment Sub-sector including Districts Dairi, Humbang Hasundutan Regency, Toba Regency, North Tapanuli Regency, Samosir Regency, North Sumatra Province, Magelang Regency, Central Java Province, Bangka Regency, Bangka Belitung Islands Province, North Minahasa Regency, North Sulawesi Province, Malang Regency, East Java Province, Wakatobi Regency, Southeast Sulawesi Province.

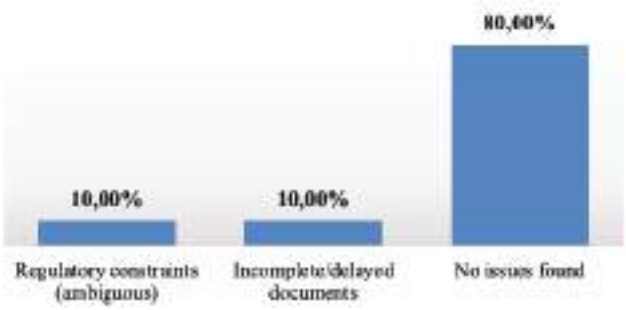
The results of the preference survey for the implementation of SAF Assignments in the Environment Sector, 10 Physical SAF recipient regions (out of 15 recipient regions) have filled out a questionnaire to give preference to the implementation of Physical SAF activities Thematic Assignment for Provision of Sustainable Economic Infrastructure in the Environment Sector 2021. On the institutional aspect, the preference for implementers of SAF in the regions shows that the majority of SAF implementers do not find issues (70.00 percent). Several issues related to institutional aspects include delays/incomplete documents (20.00 percent) and lack of synchronization between institutions (10.00 percent).



Source: Analysis Results, 2021

Figure 6. Constraints to Implementation of SAF Assignment of the Environment Sub-sector on Institutional Aspects

Several other issues in the institutional aspect include 1) Overlapping activities with the Public Works and Public Housing Services, particularly sanitation and waste management, requiring cross-agency coordination, which slows implementation time; 2) Community-level group institutions are not yet optimal due to low management commitment, regeneration, and legality, so the effectiveness of SAF implementation and post-implementation is not optimal; 3) The unavailability of an adequate number and capacity of human resources so that work management is not maximized between the administrative division and technical implementers in the field; 4) Not optimal coordination with other institutions, such as the Regional Planning Agency, Settlement Agency, and Environment Agency are not able to be independently related to their duties and functions, so implementation is slow; 5) Delays in activities due to a review involving APIP if the review materials are not fully prepared, resulting in the review process takes a long time; 6) Not optimal utilization of river water EWS because many institutions handle river areas; 7) Not optimal coordination in several regions (eg. Kulon Progo Regency), especially those with two regional apparatuses (the Environment Agency and the Public Works and Housing Agency) for waste reduction and waste management; 8) Delays in fulfilling the requirements of the submitted proposals so that several regions did not receive SAF for the Environment Sub-Sector.

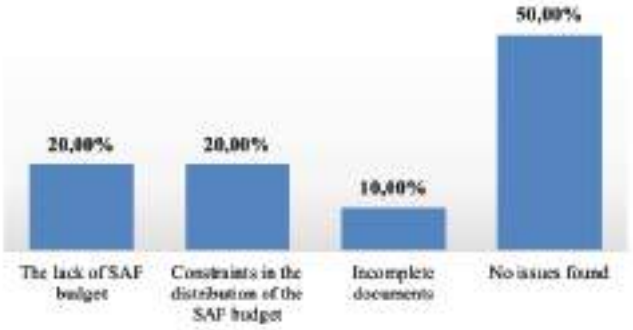


Source: Analysis Results, 2021

Figure 7. Constraints to Implementation of SAF Assignment of the Environment Sub-sector on Regulation Aspects

Regarding regulation, the preferences of SAF implementers in the regions show that most SAF implementers also experience no obstacles (80.00 percent). Several issues related to regulatory aspects include ambiguous regulatory constraints (10.00 percent) and incomplete documents (10.00 percent). Several other issues in the technical aspects of regulation include 1) Existing regulations are not yet optimal because existing regulations require SAF proposals in the environmental sector to be regional issues so that SAF activities cannot yet handle local issues; 2) The delays in activities due to regional refocusing policies have resulted in the unavailability of matching funds for SAF; 3) SAF

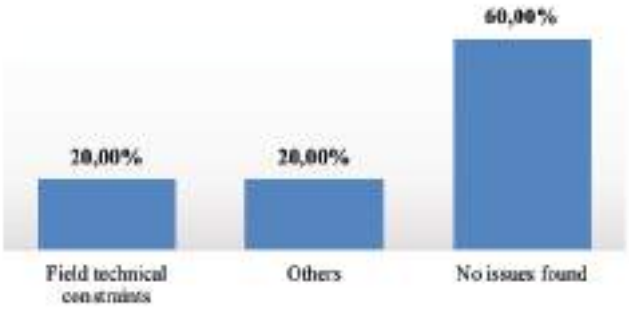
technical guidelines that are valid for >one year are not yet available to accelerate the implementation of activities. The SAF technical guidelines change every year, resulting the implementation needs to wait for the SAF technical guidelines to be issued; 4) There were constraints on the situation and conditions of the COVID-19 pandemic so that the fulfillment of the deadline for the disbursement of phase one was delayed; 5) Delays in submitting the list of contracts due to doubts by the regional apparratus to carry out activities during the COVID-19 pandemic; 6) The menu for using SAF is not flexible so that SAF activities are not fully suitable with regional needs; 7) Complicated requirements on Item readiness criteria (eg. location certificate) thereby slowing down the implementation time; 8) Lack of understanding of Human Resources in the Regional Apparatus Organization technically in the process and rules for proposing Physical SAF budget so that SAF implementation is delayed; 9) The SAF assignment of ONLIMO is not yet appropriate so that SAF activities are not yet effective in supporting regional problems.



Source: Analysis Results, 2021

Figure 8. Constraints to Implementation of SAF Assignment of the Environment Sub-sector on Funding Aspects

Regarding funding, the preferences of SAF implementers in the regions show that most SAF implementers also have no problems (50.00 percent). There are several issues related to the funding aspect, including the lack of a SAF budget (20.00 percent), constraints in the distribution of the SAF budget (20.00 percent), and constraints on incomplete documents (10.00 percent). Several other issues in the funding aspect include: 1) The unavailability of supporting costs for SAF for the Environment sub-sector, including the absence of a budget for planning and supervision, causes the regions to need to allocate budgets for support costs, preparation of planning and supervision, while the impact of refocusing in the regions causes the Local Government Budget limited; 2) Insufficient operational and maintenance costs in the regions so that maintenance of SAF physical facilities can be neglected; 3) The KRISNA menu for the Environment sub-sector is not yet optimal, which only provides a menu for waste management and environmental quality monitoring equipment, while problems in the environmental sector are very complex, not only physically but non-physically so that the Physical SAF does not optimally support the effectiveness of waste problems; 4) Limited Local Government Budget for supporting facilities for laboratory services, so that laboratory services are not yet optimal; 5) Dependence on the process of disbursing funding with other packages across OPDs which causes the distribution to run slowly; 6) The limited capacity of human resources in the technical Regional Apparatus Organization (OPD) causes the preparation of the RAB to proceed slowly due to the HR not understanding the fulfillment of the proposal requirements; 7) There has been a change in the budgeting system the post-regulation from the Ministry of Home Affairs, so the implementation of SAF activities is backward; 8) The existence of SAF allocations causes pure Local Government Budget support in regional apparatus to be reduced, thereby affecting the performance of the environmental program as a whole.



Source: Analysis Results, 2021

Figure 9. Constraints to Implementation of SAF Assignment of the Environment Sub-sector on Technical Implementation Aspects

On the technical implementation aspect, the preferences of SAF implementers in the regions show that most SAF implementers also experience no problems (60.00 percent). Several issues related to the technical aspects of implementation include technical field constraints (20.00 percent). Several other issues in the technical aspects of implementation include 1) Delays in the implementation of SAF activities due to waiting for operational instructions to be published so that the implementation of activities generally takes place at the end of the year; 2) The equipment price survey was not yet optimal during the COVID-19 pandemic because it could not be carried out face-to-face, so they lacked confidence in the implementation of activities; 3) The slow process of selecting the procurement of goods/services in the Electronic System Service Institution application and the limited specifications of goods available through e-catalog. In goods procurement activities, there are times when goods are not available in the e-catalog, this

causes activities to run slowly or not to be carried out; 4) The lack of technical personnel in the implementation of SAF activities has resulted in the slow implementation of activities, especially during the planning, monitoring, and supervision stages; 5) The delay in the delivery of goods is due to the government's policy on CARE in tackling/preventing the COVID-19 pandemic, this also affects the realization of financial achievements; 6) There are inconsistent policies at the central level. For example, at the time of the proposal, the central government only asked for a statement letter on land availability, but during synchronization and harmonization, the requested documents were in the form of land certificates/grant letters/deeds of sale and purchase so that the regions experienced delays in preparing supporting documents; 7) The implementation of work by the provider is hampered due to the Community Activities Restrictions Enforcement (CARE) policy; 8) The implementation of type 4 self-management is hampered because community groups as executors of activities experience funding difficulties. The Commitment Making Officer did not give an advance payment (payment according to achievements in the field), delaying the work implementation because the community group did not have sufficient capital.

The local government has made various efforts to deal with obstacles and problems, especially the implementation of Physical SAF Assignment of the Environment Sub-sector during the COVID-19 pandemic, including 1) Implementation of Physical SAF during the COVID-19 pandemic is the same as the implementation of other sectors, both originating from Regional and Provincial Budget and State Budget, namely following the Health Protocol to prevent transmission of COVID-19; 2) Regions identify priority scale activities and make efforts to accelerate the implementation of both administrative and technical activities; 3) Regions issue Circular Letters for accelerating the implementation and adjustments to the use of local labor; 4) Prioritizing waste facilities and infrastructure needed for the smooth operation of the waste management sector; 5) Through fast and online bidding processes while still paying attention to the physical quality of the work; 6) Carry out activities with due observance of health protocols and carry out several stages of selecting goods providers with an online/online/zoom system; 7) Collaborate or recruit HR from other regional apparatus who have related technical expertise; 8) Providing Personal Protective Equipment (PPE) to cleaning staff, gloves, cloth masks, helmets, boat shoes, and other cleaning equipment; 9) Even though there are regulations from the Regional Head regarding WFH and WFO, still optimizing the time to coordinate with the Working Group Team so that activities are realized on time; 10) Encouraging the workforce to comply with health protocols and the implementation time is extended due to a lack of labor; 11) There are directions from regional leaders to prioritize local providers and involve local communities with labor-intensive schemes in the implementation of Physical SAF in the procurement of construction services and other services.

CONCLUSION

Environmental development requires optimizing funding synergies between local governments and the central government. This fund is considered a strategic financing option because it is conceptually aimed at improving environmental quality to increase waste reduction achievements in the regions and improve waste handling in the context of providing sustainable economic infrastructure in priority locations. In 2021, the Physical SAF of PSEI Thematic Assignments for the FY 2021 Environment Sub-Sector will only be allocated to regions in 8 (eight) provinces. It means that 26 regions in Indonesia do not have PSEI Physical Assignment SAF budgets for the Environment Sector in FY 2021. From these eight provinces, seven areas are in a low category (green zone with an allocation of 4-12 billion rupiahs), no regions in the medium classification (orange zone with 12-20 billion rupiahs allocation), and one region in the high category (red zone with 20-28 billion rupiahs allocation).

Based on the questionnaire, it is known that for the Physical SAF Thematic Assignments of PSEI for the Environmental Sub-sector for the FY 2021 on the institutional aspect, in preference to SAF implementers in the regions indicating that there are obstacles to delays/incomplete files, lack of synchronization and coordination between agencies, as well as problems with the length of APIP review. In the regulatory aspect, there are ambiguous regulatory constraints that are according to the regional perspective, problems with incomplete documents, delays in submitting contract lists due to doubts by regional apparatus to carry out activities during the COVID-19 pandemic, and a lack of understanding of SAF implementers in the regions. Meanwhile, regarding the funding aspect, there are several issues about the lack of a SAF budget, constraints on distributing the SAF budget, and incomplete documents that constrain the implementation. Regarding the technical implementation aspect, the preferences of SAF implementers in the regions indicate that several issues need attention, such as the not optimal survey of equipment prices during the COVID-19 pandemic. Because they could not carry it out face-to-face, they lacked confidence in implementing activities. Another thing from the technical side is the slow procurement, lack of human resources, and technical constraints due to CARE's policies during the pandemic.

RECOMMENDATION

Based on the analysis of budget distribution, analysis of Regional Priority Synergies related to the Environment with the Physical SAF Menu, as well as the findings of problems resulting from the survey, several policies are recommended that can improve and perfect the implementation of the Physical SAF policy for the Assignment of the Environment Sub-Sector in the future. Some of these recommendations include: a) The need for policies that direct and support the implementation of activities that were contractual before to become self-managed to increase community participation in implementing activities so that people are more empowered (increasing their income) during the COVID-19 pandemic; b) The need for supporting costs that can be used in achieving activity outcomes, not just achieving activity outputs; c) The need for allocation of mentoring funds for waste management training in Physical SAF activities for the Environment Sub-Sector; d) The process of distributing SAF funds is needed to be faster so that there are no complaints from providers when the work is completed; e) The need for allocation of Physical SAF for the Assignment of the Environmental Sub-sector, which pays attention to the alignment of border areas and also small islands that require environmental management; f) The need to expand the scope of district/city needs in the Environment sub-sector, not only regional but also local needs; g) The need to provide specifications for goods/services through an adequate e-Catalog.

On the other hand, if it is related to national priorities, it must align the implementation of Physical SAF Assignments (not only related to the environment) with National and Regional Priority Programs which are made periodically, for example, for three years, so that the implementation of SAF activities has a realistic and clear impact. Another thing that needs attention is determining priority locations based on regional standards and proposals and the types of goods adapted to regional needs. Before proposing SAF, regions should be allowed to propose activities so that the SAF menu in the KRISNA application is related to regional conditions.

Problems with regional understanding regarding SAF and its dynamics require intensive socialization and information dissemination efforts if there are changes related to regulations, implementation procedures, and disbursement procedures. In addition, information on SAF proposals should be made earlier so that planning is more mature in the regions as SAF executors. In general, local governments state that the existing menu to be adjusted to the priority needs of environmental management in the regions. Therefore, synchronization between the center and the province/regency/city is suggested to be more intensive during the proposal process so that the regional needs and the center's interests can be aligned and consistent. Next, an important thing that may rarely be a concern but is relevant to realistic conditions on the field is the need to improve the Physical SAF menu for the Assignment of the Environment Sub-sector according to the needs and characteristics of the Regency/City area. For example, should be a marine debris boat menu in coastal zones.

ACKNOWLEDGEMENT

Thanks to the Directorate of Monitoring, Evaluating, and Controlling Regional Development Bappenas for providing the opportunity, knowledge, and facility support. I would also like to express my gratitude to the following person: my current director Agustin Arry Yanna, SS., MA.; my mentor Dr. Ir. Medrilzam; my former director Ir. Basah Hernowo, MA., and Ir. Wahyuningsih Darajati, M.Sc.; my team member Devy Paramitha Agnelia, S.T., M.PWK; as well as all staff of the Directorate of Monitoring, Evaluating, and Controlling Regional Development Bappenas for helpful comments on the initial draft of the paper.

REFERENCES

Al-Qudah, A. A., Al-Okaily, M., & Alqudah, H. (2021). The relationship between social entrepreneurship and sustainable development from economic growth perspective: 15 "RCEP" countries. *Journal of Sustainable Finance & Investment, 1–18*. doi:10.1080/20430795.2021.1880219

Castro, C. J. (2004). *Sustainable Development. Organization & Environment, 17(2)*, 195–225. doi:10.1177/1086026604264910

Common, M., & Stagl, S. (2005). *Ecological Economics: An Introduction*. New York: Cambridge University Press. https://doi.org/10.1017/CBO9780511805547

Cumming, G. S. (2016). The relevance and resilience of protected areas in the Anthropocene. *Anthropocene, 13, 46–56*. doi:10.1016/j.ancene.2016.03.003

Fauziyah, S., & Trisnawati, R. (2022). Pengaruh Produk Domestik Regional Bruto (PRDB), Indeks Pembangunan Manusia (IPM), Dana Pihak Ketiga Perbankan Syariah (DPK), Indeks Kualitas Lingkungan Hidup (IKLH), dan Dana Alokasi Khusus (DAK) terhadap perkembangan Sustainable Development Goals (SDGs). *Eqien - Jurnal Ekonomi dan Bisnis, 11 (1), 1428-1237*. https://doi.org/10.34308/eqien.v11i1.881

GoI. (2021a). *Peraturan Menteri Keuangan (PMK 17/PMK.07/2021) tentang Pengelolaan Transfer ke Daerah dan Dana Desa Tahun Anggaran 2021 dalam rangka Mendukung Penanganan Pandemi Corona Virus Disease 2019 (COVID-19) dan Dampaknya (Berita Negara Republik Indonesia Tahun 2021 Nomor 149)*. Jakarta: Pemerintah Indonesia (Government of Indonesia)

GoI. (2021b). *Peraturan Menteri Keuangan (PMK 94/PMK.07/2021) tentang Perubahan Atas Peraturan Menteri Keuangan Nomor 17/PMK.07/2021 tentang Pengelolaan Transfer ke Daerah dan Dana Desa Tahun Anggaran 2021 dalam rangka Mendukung Penanganan Pandemi Corona Virus Disease 2019 (COVID-19) dan Dampaknya (Berita Negara Republik Indonesia Tahun 2021 Nomor 149)*. Jakarta: Pemerintah Indonesia (Government of Indonesia)

GoI. (2020a). *Undang-Undang Nomor 9 Tahun 2020 tentang Anggaran Pendapatan dan Belanja Negara Tahun Anggaran 2021 Lembaran Negara Republik Indonesia Tahun 2020 Nomor 239)*. Jakarta: Pemerintah Indonesia (Government of Indonesia)

GoI. (2020b). *Peraturan Presiden Nomor 18 Tahun 2020 tentang Rencana Pembangunan Jangka Menengah Nasional Tahun 2020-2024 (Lembaran Negara Republik Indonesia Tahun 2020 Nomor 10)*. Jakarta: Pemerintah Indonesia (Government of Indonesia)

GoI. (2020c). *Peraturan Presiden Nomor 86 Tahun 2020 tentang Rencana Kerja Pemerintah Tahun 2021 (Lembaran Negara Republik Indonesia Tahun 2020 Nomor 304)*. Jakarta: Pemerintah Indonesia (Government of Indonesia)

GoI. (2020d). *Peraturan Presiden Nomor 123 Tahun 2020 tentang Petunjuk Teknis Dana Alokasi Khusus Fisik Tahun Anggaran 2021 (Lembaran Negara Republik Indonesia Tahun 2020 Nomor 309)*. Jakarta: Pemerintah Indonesia (Government of Indonesia)

Mina, R. (2016). Desentralisasi Perlindungan dan Pengelolaan Lingkungan Hidup sebagai Alternatif Menyelesaikan Permasalahan Lingkungan Hidup. *Arena Hukum, 9(2), 149–165*. https://doi.org/10.21776/ub.arenahukum.2016.00902.1

Mtibaa, S., Hotta, N., & Irie, M. (2018). Analysis of the efficacy and cost-effectiveness of best management practices for controlling sediment yield: A case study of the Joumine watershed, Tunisia. *Science of The Total Environment, 616-617, 1–16*. doi:10.1016/j.scitotenv.2017.10.290

Pambudi, A.S., Hidayati, S., & Pramujo, B. (2022). Analisis Permasalahan Pembangunan Infrastruktur Jalan: Studi Kasus Perencanaan dan Pelaksanaan di Provinsi Papua Barat. *Publisia: Jurnal Ilmu Administrasi Publik, 7(2), 188 - 210*. DOI:https://doi.org/10.26905/pjiap.v7i2.7645

Pambudi, A.S. (2021). Kendala Adaptasi Pemerintah Daerah Dalam Implementasi DAK Fisik Saat Pandemi COVID-19. *Jurnal Ilmiah Wahana Bhakti Praja. 11 (1), 1-17*. https://doi.org/10.33701/jiwbp.v11i1.1536

Pambudi, A. S. (2020a). System Dynamics Modelling of Deforestation Rate and Forest Rehabilitation in the Upstream of Ciliwung Watershed, Bogor Regency. *Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning, 4(3), 327-346*. https://doi.org/10.36574/jpp.v4i3.121

Pambudi, A. S. (2020b). Evaluasi Kesesuaian RKP dan RKPD 34 Provinsi terkait DAK Fisik Penugasan Bidang Lingkungan Hidup dan Kehutanan 2019. *Bappenas Working Papers, 3 (1), 88-100*. https://doi.org/10.47266/bwp.v3i1.58

Pambudi, A. S. (2019). Water Price Calculations in Concept of Environmental Service: A Case in Cimanuk Watershed. Jurnal Perencanaan Pembangunan: *The Indonesian Journal of Development Planning, 3(3), 325-337*. https://doi.org/10.36574/jpp.v3i3.84

Sinukaban, Naik. (2007). *Peranan Konservasi Tanah dan Air dalam Pengelolaan Daerah Aliran Sungai*. Jakarta: Prosiding Bunga Rampai Konservasi Tanah dan Air.

Soemarwoto, Otto (1999). *Analisis Mengenai Dampak Lingkungan*. Yogyakarta: Gadjah Mada University Press.

Watson, J. E. M., Dudley, N., Segan, D. B., & Hockings, M. (2014). The performance and potential of protected areas. *Nature, 515(7525), 67–73*. doi:10.1038/nature13947

InJAST
Volume 4, Number 1, April 2023
Pages: 22-29

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.6644

Spatial analysis of paddy field conversion in Purwakarta Regency, West Java, Indonesia

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Submitted 14 December 2022; Accepted 22 January 2023

ABSTRACT

Food is a basic human need. The state must strive to meet the availability of food for people sustainably. One of the efforts is to maintain and develop paddy fields as a food source and a supplier of 95% of national rice production. The conversion of paddy fields is a reason for decreasing food production in Purwakarta Regency, which impacts food availability and security. This research aimed to portray the conversion rate of paddy fields in Purwakarta. This quantitative descriptive research uses spatial analysis to compare the 2013-2017 and the 2017-2021 periods. The results of spatial analysis in the 2013-2017 period showed that Purwakarta Regency experienced a reduction in paddy fields by 195.55 ha (1%) consisting of paddy fields turned into industry 117.99 ha; roads 5.72 ha; settlements of 42.30 ha and housing, trade and services of 29.55 ha. Meanwhile, in 2013-2017, paddy fields turned into industry by 151.72 ha, roads by 23.54 ha, settlements by 196.76 ha, and housing, trade, and services by 29.81 ha. The results of this study reinforce that the reduction in food production in Purwakarta was caused by the conversion of paddy fields into other uses during the 2013-2017 and 2017-2021 periods.

ABSTRAK

Pangan merupakan kebutuhan pokok manusia. Negara harus berupaya untuk memenuhi ketersediaan pangan bagi masyarakat secara berkelanjutan. Salah satu upayanya adalah mempertahankan dan mengembangkan sawah sebagai sumber pangan dan pemasok 95% produksi beras nasional. Alih fungsi lahan sawah menjadi penyebab penurunan produksi pangan di Kabupaten Purwakarta yang berdampak pada ketersediaan dan ketahanan pangan. Penelitian ini bertujuan untuk menggambarkan laju konversi lahan sawah di Purwakarta. Penelitian deskriptif kuantitatif ini menggunakan analisis spasial untuk membandingkan periode 2013-2017 dan periode 2017-2021. Hasil analisis spasial periode 2013-2017 menunjukkan Kabupaten Purwakarta mengalami pengurangan lahan sawah sebesar 195,55 ha (1%) yang terdiri dari lahan sawah berubah menjadi industri 117,99 ha; jalan 5,72 ha; permukiman seluas 42,30 ha dan perumahan, perdagangan dan jasa seluas 29,55 ha. Sedangkan pada tahun 2013-2017, lahan sawah berubah menjadi industri seluas 151,72 ha, jalan raya seluas 23,54 ha, pemukiman seluas 196,76 ha, serta perumahan, perdagangan, dan jasa seluas 29,81 ha. Hasil penelitian ini memperkuat bahwa penurunan produksi pangan di Purwakarta disebabkan oleh alih fungsi lahan sawah menjadi peruntukan lain selama periode 2013-2017 dan 2017-2021.

Keywords: *food production, food sustainability, paddy field conversion, Purwakarta*

INTRODUCTION

Food is a basic human need. The fulfillment of food is a human right. The Government is responsible for the availability of food. This food supply is realized to sustainably meet the needs and consumption of food for the community, households, and individuals. One of the efforts to realize domestic food availability is to maintain and develop productive land (article 12, paragraph 5 letter e of Law 18 of 2012).

Rice is a major component of the national food security system (Permadi and Sunandar, 2013). It is estimated that around 95 percent of national rice production is supplied from paddy fields, and only 5 percent comes from dry land, so paddy fields are still considered very strategic in fulfilling national rice needs in the future (Setyorini et al. 2010). Agriculture and food production save Asia from famine and help the country and provide food for its citizens (Waage, 2022).

Purwakarta Regency topographically has a lowland area reaching 52.60 percent of the Purwakarta Regency area, making it suitable for paddy fields (BPS, 2021). The agricultural sector contributes significantly to the economic structure of Purwakarta Regency by 6.90 percent of the total Gross Regional Domestic Product (GRDP). This is also confirmed in the 2018-2023 Purwakarta Regency Regional Medium-Term Development Plan (RPJMD) document that the

development of the food and agriculture sector is a priority for the development of Purwakarta Regency, as coined by the term "the realization of food security and increasing the competitiveness of agriculture, fisheries and animal husbandry."

One of the challenges in food security in the Purwakarta Regency is the competition for space utilization. Paddy fields are often decreased by other spaces to accommodate the interests of economic development and investment. In 2017-2020, there was a decrease in harvest and rice production in Purwakarta (BPS, 2021). The reduction in rice production in Purwakarta Regency certainly impacts food availability both in Purwakarta Regency and West Java Province and even nationally. This research aimed to provide a portrait of the rate of paddy field conversion to provide input on the policy direction of the Purwakarta Regency Government in realizing food security.

METHODS

Time and Location

The study was conducted in January-April 2022 in Purwakarta Regency, West Java (Figure 1), within the data of the rice field area of Purwakarta Regency in 2013-2017 and 2017-2021.

Tools and Materials

The tools and materials used during the study were computers with the *Microsoft Excel* program, *ArcGIS 10.8*, *Powersim 10*, and *Google Earth Pro*.

Secondary Quantitative Data

The secondary data used in this study are shown in Table 1 below.

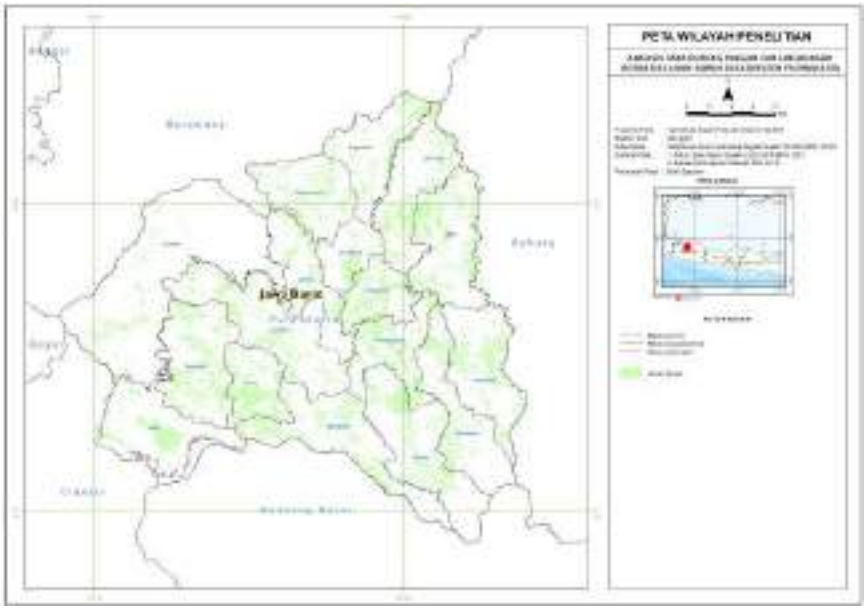

Figure 1. Map of the research area in Puwakarta Regency, West Java.

Table 1. Data types and sources

Data type	Data form	Year	Sources
Paddy field land	Shapefile	2013	ATR/BPN
Paddy field land	Shapefile	2021	Purwakarta Govt.
Land pattern	Shp.	2012	Purwakarta Govt.
High-resolution satellite image	Image	2018	LAPAN
Sentinel satellite image	Image	2017, 2021	European Space Agency
Administrative boundaries	Shp.	2018	BIG

Research Procedures

This quantitative descriptive research uses secondary data, consisting of collecting, processing, and analysis. The method is interpreting overlay between Sentinel image 2013 and a high-resolution satellite imagery SPOTS 6 of 2018, as well as with the 2021 of Sentinel image interpretation, and also *Google Earth* satellite image compilation. According to Irwansyah (2013), the overlay method is a spatial analysis method by combining two or more spatial data to produce a new layer.

The overlay technique uses the *union tool* with the scheme as shown in Figure 2. After overlaying, the subsequent analysis was with the interpretation of SPOTS 6 of 2018 imagery, sentinel imagery, and *Google*

Earth satellite imagery compilation sharpened the interpretation.

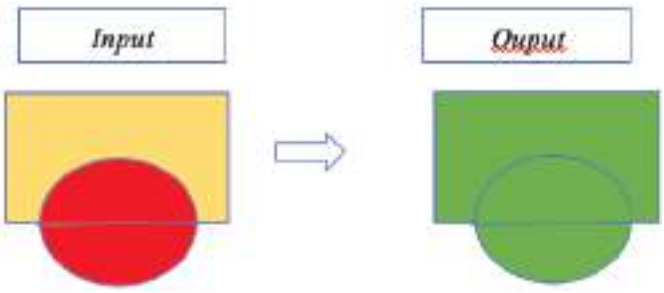

Figure 2. Union tool scheme on overlay method.

The conversion rate of paddy fields uses a two-period approach, namely the 2013-2017 period and the 2017-2021 period, with the same analysis method. In the 2013-2017 period, one of the obstacles was the unavailability of the 2017 spatial data. The 2017 paddy spatial data was then created by overlaying the 2013 data with the 2017 Sentinel image and compiled it with the Google Earth satellite image to help sharpen the imagery interpretation. After that, the working steps are carried out according to Figure 3. Meanwhile, in the 2017-2021 period, the data is available, and the working steps, according to Figure 4.

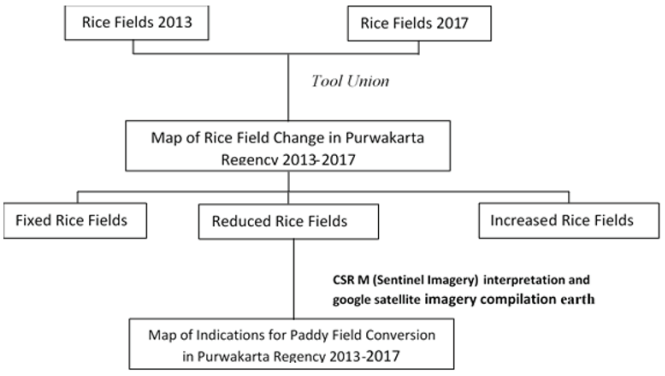

Figure 3. Spatial-based paddy field conversion rate analysis of Purwakarta Regency in 2013-2017.

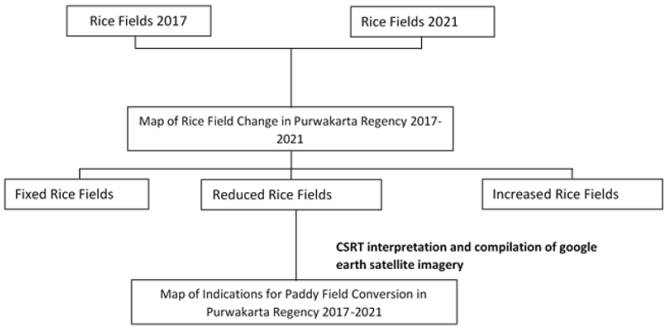

Figure 4. Spatial-based paddy field conversion rate analysis work steps for Purwakarta Regency in 2017-2021.

Spatial-based rice field conversion rate analysis for the 2013-2017 and 2017-2021 periods is expected to describe the rate of paddy field conversion in the four years in Purwakarta Regency. In addition to the rate of conversion of paddy fields, spatial-based analysis with a map scale of 1: 5.000 will also provide an overview of the tendency of changes in allotment from paddy fields to other designations. It would be easier for the Purwakarta Regency government to control the rate of conversion of paddy fields in the following year.

RESULTS AND DISCUSSION

One of the crucial factors in the context of food security in an area is the availability of paddy fields. The larger the rice field, the higher the food production produced. According to Wahyunto and Widiastuti (2014), the conversion of paddy fields on Java Island needs to be controlled because it impacts decreasing national food production and threatens national food security. In other words, paddy fields are the main production factor (Setyorini et al. 2010).

The conversion of paddy fields is a serious threat to food sustainability in Indonesia. The conversion of paddy fields occurred before Indonesia's rapid development. Rice fields were chosen to be the object of conversion because they are easy to reach and highly accessible. From 1981 through 1986, the conversion of paddy fields in Indonesia was 37.708 ha per year, while the ability to add new paddy fields in the same period was only 31.805 ha per year (Hardjoamidjojo, 1997). In that period, 14.54% turned into settlements. Meanwhile, irrigated rice fields in West Java decreased by 90.000 ha in 1991-1994 (Hardjoamidjojo, 1997). In another study, it was reported that in the 1992-1999 period, agricultural land in Bandung Regency, covering an area of 3,134 ha (25 percent), changed its function to hotels, restaurants, housing, villas, offices, vacant land, and other buildings (Ruswandi et al. 2007).

The Rate of Conversion of Paddy Fields for the Period 2013-2017 in Purwakarta

Based on the results of spatial analysis in the 2013-2017 period, Purwakarta Regency experienced a reduction in rice fields by 195.55 ha (1%) consisting of rice fields turned into the industry by 117.99 ha; roads by 5.72 ha; into settlements of 42.30 ha and housing, trade and services of 29.55 ha (Figure 5).

Paddy fields turned into industry place the highest rank of 60% of the total area of paddy field conversion to other for the 2013-2017 period in Purwakarta Regency, followed by settlements of 22% (Figure 6). This discovery strengthens the strategic location of Purwakarta Regency, which is at the confluence between the Jakarta-Bandung and Jakarta-Cirebon, so that it has the potential to develop into a new industrial area.

Changes into built-up land generally dominate the pattern of land use change in developing areas.

Ramadan et al. (2016) reported that the conversion of paddy fields to built-up ranked second place, covering an area of 570 ha (2001-2008) and 874 ha (2008-2015) in Banjarnegara Regency.

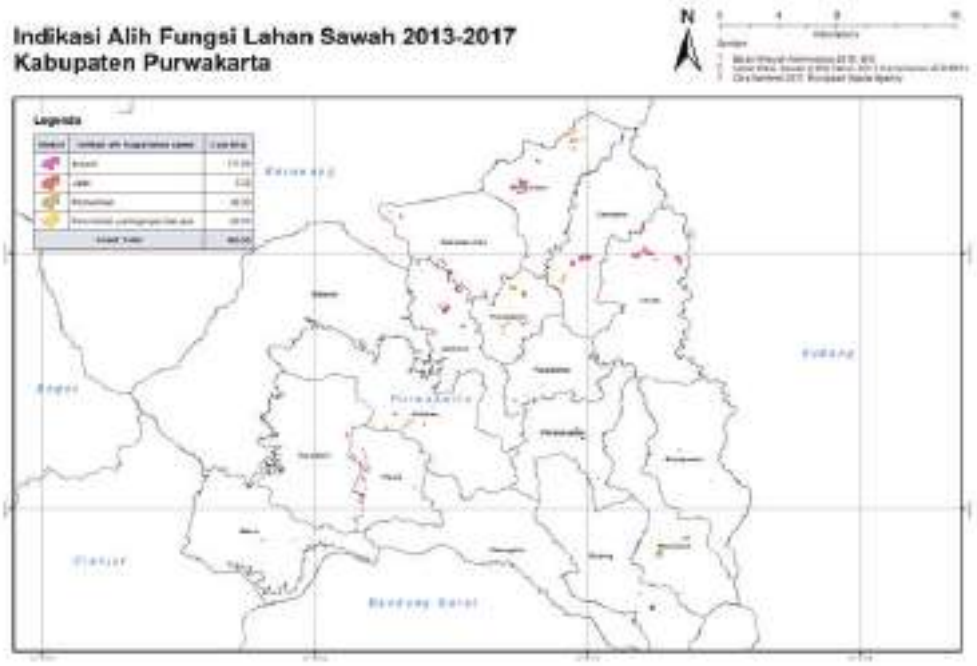

Figure 5. Indications of paddy field conversion for the 2013-2017 period in Purwakarta Regency.

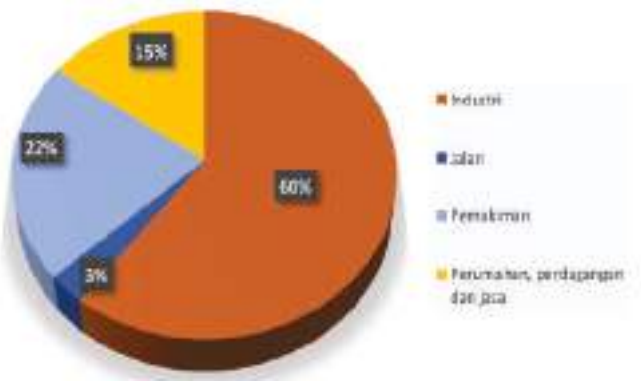

Figure 6. Indications of paddy field conversion for the 2013-2017 period in Purwakarta Regency.

The distribution of paddy field changes in the 2013-2017 period based on sub-districts is shown in Table 2.

Paddy fields turned into the industry happen almost evenly in all districts, and the highest yield is in Cibatu District at 34.38 ha. The same happens with paddy fields that become settlements, housing, trade, and services. As for the paddy fields turned into settlements, the highest yield was in Purwakarta District at 15.05 ha, while the paddy fields turned into housing, trade, and services occurred in Campaka District at 11.05 ha (Table 1.2). The change of paddy fields seriously impacts food sustainability because it is permanent, which means the change is fixed, and the fields will not produce food again. Loss of food production due to the conversion of paddy fields is more detrimental than yield loss due to the impact of drought, floods, or attacks of pests and plant diseases (Pambudi, 2021).

Table 2. The distribution of changes in paddy fields according to sub-districts in Purwakarta Regency for the 2013-2017 period.

District	Industry	Road	Settlement	housing, trade, and services
Babakancikao	16.46	0.44	0.62	2.06
Bojong	1.27	-	1.30	-
Bungursari	16.93	1.94	1.52	9.94
Campaka	24.55	-	-	11.05
Cibatu	34.38	-	1.24	0.18
Darangdan	-	-	-	-
Jatiluhur	10.84	-	1.13	-
Kiarapedes	0.34	-	0.27	1.54
Manis	1.00	-	-	-
Pasawahan	-	-	2.26	1.94
Plered	4.19	1.72	0.21	-
Pondoksalam	0.17	-	3.42	-
Purwakarta	2.16	-	15.05	0.57
Sukasari	-	-	-	-
Sukatani	1.99	0.82	3.61	0.79
Tegalwaru	3.71	0.79	1.82	-
Wanayasa	-	-	9.85	1.47
Grand Total	**117.99**	**5.72**	**42.30**	**29.55**

Rate of Paddy Field Conversion for the 2017-2021 Period in Purwakarta

The results of spatial analysis of the rate of conversion of paddy fields in Purwakarta Regency for the 2017-2021 period showed that the change of paddy

fields into settlements was quite significant, namely 196.76 ha, followed by turning into the industry by 151.72 ha, turned into housing, trade, and services by 29.81 ha, and turned into roads by 23.54 ha (Figure 7).

In the 2017-2021 period, changes of paddy fields turned into housing ranked highest at 49%, followed by industry at 38% of the total area (Figure 8). Interesting results are also shown in the analysis results in the 2017-2021 period, which is the change of paddy fields into shrubs/ thickets reaching 2,123.91 ha or 84.09% of the total rice field area. The conversion of rice paddy fields into shrublands or thickets is a reversible process

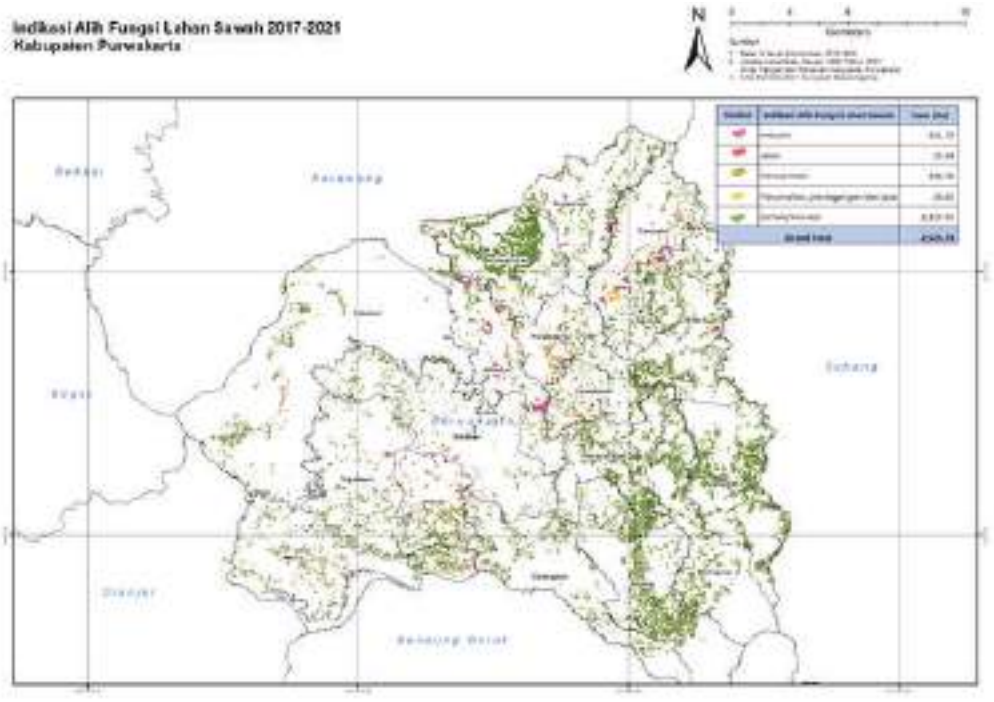

Figure 7. Indications of paddy field conversion for the 2017-2021 period in Purwakarta Regency.

Figure 8. Indications of paddy field conversion for the 2017-2021 period in Purwakarta Regency.

that can be restored to its original state by applying appropriate cultivation techniques. This restoration can effectively contribute to the production of food once again. Several factors cause paddy fields turning into shrubs/thickets, one of which is water availability. Water scarcity prevents the land from being cultivated, while excessive water, such as flooding, yields a similar outcome.

In just four years, the industry sector in Purwakarta Regency overgrew. One example of the above phenomenon is the rise in demand for land set aside for industrial estates, which has led to net growth of 151.72 hectares from 2013 to 2021. This growth has taken over rice fields with a total size of 269.71 hectares. This data shows an increasing trend. The same thing also happened to the rice fields that changed for settlement. In the 2013-2017 period, the rice fields that changed for settlement were only 42.30 ha, but in the 2017-2021 period, the rice fields that changed for settlements increased rapidly by 196.76 ha or 465%. As for housing,

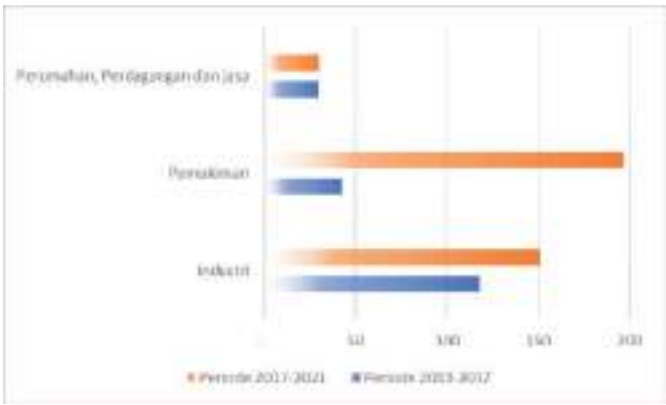

Figure 9. Indications of changes in paddy fields in the 2013-2017 and 2017-2021 periods in Purwakarta Regency.

trade, and services, the increase is relatively small (Figure 9).

Based on a spatial and quantitative analysis reported by Sukiptiyah (2022), the conversion of paddy fields in West Java in the 2013-2018 period is divided into 2 (two) patterns. The first pattern is a conversion in rural areas with high industrialization and urbanization with an area of thousands of hectares. The second is in rural areas with low industrialization and urbanization with a conversion area of only tens or hundreds of hectares. Based on those patterns, Purwakarta has low industrialization and urbanization because land conversion ranges from tens to hundreds of hectares. However, if the trend continues to increase, Purwakarta Regency may develop toward high industrialization and urbanization. This trend must be anticipated because Purwakarta Regency has quite good agricultural potential.

Population growth generally encourages housing needs and consumption of agricultural products, thus encouraging the conversion of paddy fields. The conversion of paddy fields in West Java has turned chiefly into built-up land for settlements/housing, and industry/trade (Sukiptiyah, 2022). Ichwal et al. (2019) reported a similar finding that the conversion of paddy fields into housing and public facilities in Darul Imarah District, Aceh Besar Regency, is due to its strategic location and growing population. This housing development impacts the surrounding rice fields because it hinders irrigation canals which causes these paddy fields to become unproductive, leading to subsequent conversion of paddy fields.

The distribution of paddy field changes in the 2017-2021 period based on sub-districts showed in Table 3. In the 2017-2021 period, paddy fields that turned into industries were also evenly distributed in all districts, although a fairly large area was patterned in several districts, namely Bungursari; Campaka; Cibatu; Jatiluhur; and Plered (Table 1.3). Paddy fields turned into an industry in the 2017-2021 period, found largest in Jatiluhur District, covering an area of 54.24 ha, while turning into the largest housing is in Purwakarta District, covering an area of 28.32 ha, and turned into housing, trade, and services showed largest in Campaka District covering an area of 19.59 ha.

Based on the comparison of the period 2013-2017 with 2017-2021 according to the sub-district, the pattern of the regional development center is coined. Industrial areas are centralized in several sub-districts: Bungursari; Campaka; Cibatu; and Jatiluhur. Plered District in the 2013-2017 period was not an industrial area, but in the 2017-2021 period, it developed into an industrial area with an area of rice fields that turned into an industry of 15.34 ha. Residential development is centralized in Purwakarta District, the capital of Purwakarta Regency, while it also occurs in Campaka District. Campaka Subdistrict is not only turned into a residential development but also a center for housing development, trade, and services.

Campaka Subdistrict was originally an agricultural area before being developed into an industrial area in early 2000. In 2017 Campaka District was growing into an industrial area and home industry handicrafts from industrial waste (https://ppid.purwakartakab.go.id).

Table 3. The distribution of changes in paddy fields according to sub-districts in Purwakarta Regency for the 2017-2021 period.

District	Industry	Road	Settlement	Housing, trade, and services	Bush
Babakancikao	6.67	0.13	11.78	8.75	638.29
Bojong	-	-	6.34	-	147.88
Bungursari	20.67	0.81	9.63	0.33	123.28
Campaka	22.62	6.64	28.25	19.59	87.44
Cibatu	16.55	1.18	12.45	-	194.31
Darangdan	4.34	0.70	5.51	-	83.05
Jatiluhur	54.24	6.27	9.74	1.14	77.75
Kiarapedes	0.37	0.19	6.56	-	186.33
Manis	-	-	4.96	-	36.16
Pasawahan	2.16	1.13	14.91	-	53.48
Plered	15.34	1.98	16.69	-	37.58
Pondoksalam	0.87	-	6.31	-	105.02
Purwakarta	0.97	-	28.32	-	19.51
Sukasari	0.45	3.95	6.49	-	73.05
Sukatani	2.88	0.05	6.74	-	99.32
Tegalwaru	3.11	0.24	5.41	-	52.98
Wanayasa	0.49	0.26	16.66	-	108.48
Grand Total	**151.72**	**23.54**	**196.76**	**29.81**	**2,132.91**

This present state indicates that the rice fields in Campaka District have changed their functions to become centers of industry, settlement, housing, trade, and services.

CONCLUSION

Based on the results of the study, the conclusion is as follows:

1. In the 2013-2017 period, there was a reduction in rice fields to a built-up area of 195.55 ha, and in the 2017-2021 period a reduction in paddy fields to a built-up area of 401.83 ha.
2. In the 2013-2017 period, paddy fields turned into an industry occupying the highest rank of 60%, followed by settlements of 22% of the total area of paddy fields in Purwakarta Regency.
3. In 2017-2021, paddy fields turned into housing ranked highest at 49%, followed by industry at 38% of the total area of paddy fields in Purwakarta Regency.

REFERENCES

Bappenas. (2017). *Terjemahan Tujuan & Target Global Tujuan Pembangunan Berkelanjutan (TPB)/ Sustainable Development Goals (SDGs)*. Kementerian Perencanaan Pembangunan Nasional/ Badan Perencanaan Pembangunan Nasional.

Bappenas. (2021). *Kebijakan Pembangunan Berketahanan Iklim 2020-2045*. Jakarta: Bappenas.

BPS RI. (2018). *Proyeksi Penduduk Indonesia 2015 – 2045. Hasil SUPAS 2015 (Edisi Revisi)*. BPS RI.

BPS RI. (2022). *Produktivitas Tanaman Padi (Satuan Kw) (Kuintal/Hektar), 2020-2021*. Diakses pada: https://jabar.bps.go.id/indicator/53/711/1/produktivitas-tanaman-padi-satuan-kw-.html. Badan Pusat Statistik Provinsi Jawa Barat.

BPS. (2014). *Produksi Padi, Jagung, dan Kedelai (Angka Sementara Tahun 2013)*. Berita Resmi Statistik. No. 22/03/ Th. XVII, 3 Maret 2014.

BPS. (2021). *Statistik daerah Kabupaten Purwakarta 2021*. Badan Pusat Statistik Kabupaten Purwakarta. Purwakarta (ID): BPS Kabupaten Purwakarta.

Firmansyah. (2016). Model Pengendalian Konversi Lahan Sawah di Dalam DAS Citarum [Tesis]. Bogor: Sekolah Pascasarjana, Institut Pertanian Bogor.

Hardjoamidjojo, S. (1997). Peranan irigasi dan permasalahannya dalam swasembada beras di Indonesia. *Buletin Keteknikan Pertanian 11(1): 44-53*.

Ichwal, Z., Romano., & Agus, N. (2019). Conversion of paddy fields and impact on farmers' income in Aceh Besar District of Indonesia: A case study of Darul Imarah Subdistrict. *Russian Journal of Agricultural and Socio-Economic Science (RJOAS) 11(95): 257-262*. DOI 10.18551/rjoas.2019-11.36

Irwansyah, E. (2013). *Sistem Informasi Geografis: Prinsip Dasar dan Pengembangan Aplikasi*. Yogyakarta: Digibooks Printing and Publishing.

Kurniawati, U.F., Handayeni, K.D.M.E., Nurlaela, S., Idajati, H., Firmansyah, F., Pratomoadmojo, N.A., Sianturi, R. & Septriadi. (2020). Pengolahan data berbasis Sistem Informasi Geografis (SIG) untuk kebutuhan penyusunan profil di Kecamatan Sukolilo. *SEGAWATI-Jurnal Pengabdian kepada Masyarakat-DRPM ITS 4(3): 190-196*.

Kustiwan, I. & Almira, L. (2012). Pemodelan dinamika perkembangan perkotaan dan daya dukung lahan di kawasan cekungan Bandung. *Tataloka 14(2): 98-112*.

Munawir. (2018). Dinamika Konversi Lahan dan Keterkaitannya dengan Ketersediaan Pangan di Kabupaten Gowa, Sulawesi Selatan [Tesis]. Bogor: Sekolah Pascasarjana Institut Pertanian Bogor.

Pambudi, A.S. (2021). Overview and evaluation of the Indonesia's water resources management policies for food security. *Indonesian Journal of Applied Environmental Studies 2(2): 84-93*. DOI: 10.33751/injast.v2i2.3586

Permadi, K. & Sunandar, B. (2013). Penerapan berbagai inovasi teknologi yang mendukung Program Peningkatan Produksi Beras Nasional (P2BN) di Kabupaten Purwakarta (review). *AGROTROP 3(1):1-9*.

Priatna, D., Saputro, B., Rosadi, & Kadar, I. (2022). Carrying capacity analysis of paddy field-based food and environment in Purwakarta Regency, West Java. *Proceeding: International Conference Multi-Diciplines Approaches for the Sustainable Development. Denpasar, Bali, Indonesia, 16 December 2022*. Universitas Dwidjendra Press. Pp. 189-198.

Ruswandy, A., Rustiadi, E., & Mudikdjo, K. (2007). Konversi lahan pertanian dan dinamika perubahan penggunaan lahan di kawasan Bandung Utara. *Jurnal Tanah dan Lingkungan 9(2): 63-70*.

Setyorini, D., Rochayati, S., & Las, I. (2010). *Membalik Kecenderungan Degradasi Sumber Daya Lahan dan Air: Pertanian pada Ekosistem Lahan Sawah* (Editor: Suradisastra K, et.al.). Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian. Bogor: IPB Press.

Sukiptiyah. (2022). Analisis Dampak Pola Peruntukan Ruang dalam Penempatan Lokasi Kegiatan Ekonomi Melalui Mekanisme Konversi Lahan Sawah di Perdesaan (Studi Kasus: Provinsi Jawa Barat) [Tesis]. Bogor: Ilmu Perencanaan Pembangunan Wilayah dan Perdesaan, Fakultas Ekonomi dan Manajemen, Sekolah Pascasarjana Institut Pertanian Bogor.

Undang-Undang Republik Indonesia Nomor 18 Tahun 2012 tentang Pangan.

Waage, J. (2022). Understanding the relationship between environment, agriculture and health: An interdisciplinary challenge. *Indonesian Journal of Applied Environmental Studies 3(1): 1-4*. DOI: 10.33751/injast.v3i1.5075

Wahyunto & Widiastuti, F. (2014). Lahan sawah sebagai pendukung ketahanan pangan serta strategi pencapaian kemandirian pangan. *Jurnal Sumberdaya Lahan Edisi Khusus: 17-30*.

Yanti, R.T., Ridwan, M., & Rospida, L. (2013). Analisis alih fungsi lahan pertanian tanaman pangan padi sawah ke sektor perkebunan kelapa sawit dan karet serta pengaruhnya terhadap Produksi padi di Kabupaten Seluma Propinsi Bengkulu. *Jurnal Ekonomi dan Perencanaan Pembangunan 5(2): 64-75*.

InJAST
Volume 4, Number 1, April 2023
Pages: 30-32

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.7162

Photographic evidence of dholes in Gunung Gede Pangrango National Park, Indonesia

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Submitted 2 February 2023; Accepted 1 April 2023

ABSTRACT

For many years the dhole was believed to have been undetected in Gunung Gede Pangrango National Park (GGPNP). Nevertheless, in 2012 and 2013, we were able to photograph this elusive creature. We report the photographic evidence of the endangered dhole (*Cuon alpinus*) using camera trap in GGPNP.

ABSTRAK

Selama bertahun-tahun, Ajag diyakini tidak terdeteksi di Taman Nasional Gunung Gede Pangrango (TNGGP). Namun pada tahun 2012 dan 2013, kami berhasil memotret spesies yang sulit diketahui ini. Kami melaporkan bukti fotografi Ajag (*Cuon alpinus*) yang terancam punah dengan menggunakan kemara penjebak di TNGGP.

Keywords: *camera trap, Cuon alpinus, distribution update, Java, management*

ARTICLE

The dhole or Asiatic wild dog (*Cuon alpinus*), listed as Endangered by the IUCN, distributed across most parts of South, East, and Southeast Asia (Zhang & Chen, 2011), including Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, and Thailand (Kamler et al., 2015).

In Indonesia, dholes are found in Sumatra and Java, although no population estimate is currently available for Indonesia (Kamler et al., 2015). However, a tiny population is assumed by Srivathsa et al. (2020), with large protected areas in Sumatra as essential core areas for dholes in Indonesia (Havmøller et al., 2022).

The existence of dhole in Sumatra was known in Bukit Barisan Selatan National Park (Allen et al., 2020), within production forest and surrounding area in Jambi Province (Maddox et al., 2007), Bukit Betabuh Protected Forest, Bukit Bungkuk Nature Reserve, and Bukit Rimbang Bukit Baling Wildlife Reserve (Widodo et al., 2020), Kampar, Kerumutan Wildlife Reserve, Peranap, Bukit Rimbang Bukit Baling, and Tesso Nilo National Park (Sunarto et al., 2015), Ulu Masen Ecosystem (Radinal et al., 2019).

Whereas in Java was known in Alas Purwo, Meru Betiri, Baluran, and Bromo Tengger Semeru National Parks, Kawah Ijen Nature Tourism Park (Durbin et al., 2004; Iyengar et al., 2005; Pudyatmoko, 2018), Mount Slamet (Sulistyadi, 2012), Ujung Kulon National Park (Rahman et al., 2018). Papandayan Nature Reserve, Gunung Sawal Wildlife Reserve, Gede Pangrango and Halimun Salak National Park (Qodri et al, 2020; Kao et al, 2020).

Java is one of the islands with the highest human population density in the world (Dsikowitzky et al., 2019). The island is home to 141 million people, equal to 1,115 people/km² (Badan Pusat Statistik, 2020). The high demand for natural resources for agricultural land has resulted in the widespread conversion of large areas of natural habitat (Sodhi et al., 2010) and the isolation of protected areas throughout Java (Kamler et al., 2015).

Dholes in Gunung Gede Pangrango National Park (GGPNP) have anecdotal evidence (Kao et al., 2020). Although Havmøller et al. (2022) stated, we failed to detect dholes in GGPNP during a camera trap study in 2018. These authors did not conduct the survey, but they cited the papers by Ario et al. (2018). Here, we report the first dhole recorded by a camera trap from 1 November 2012 to 28 February 2013 in GGPNP (Figure 1). Two photographs of dholes were captured on 11 November 2012 at 04.04 PM in the Sukabumi area of GGPNP (Figure 2) and 5 February 2013 at 01:25 PM in the Bogor area of GGPNP (Figure 3).

We believe that its evidence will be added to the distribution of dhole in an elusive and increasingly threatened carnivore. Studies on dhole presence and habitat utilization inside and outside protected areas are

highly needed for future conservation management in Java.

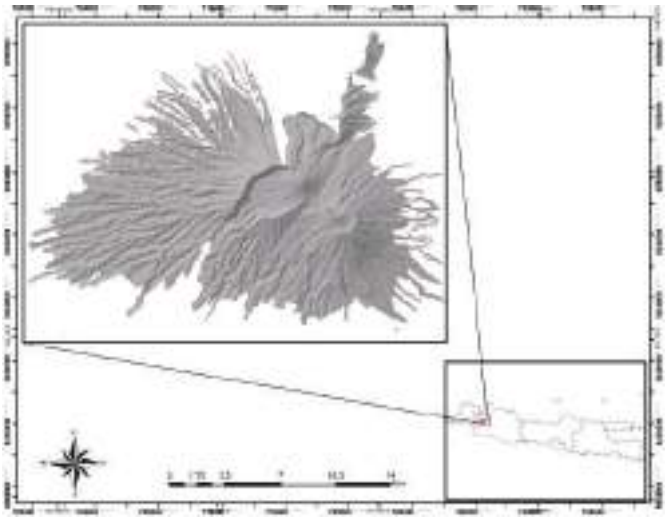

Figure 1. Map of Gunung Gede Pangrango National Park, Indonesia

Figure 2. Dhole captured in Sukabumi area

Figure 3. Dhole captured in Bogor area

ACKNOWLEDGEMENTS

This study is part of a collaboration between the Indonesian Ministry of Environment and Forestry (MoEF), and Conservation International Indonesia started in 2009-2021. We thank the MoEF for the permission to use the collected data. We are grateful to Daikin Industry Ltd. for funding support.

REFERENCES

Allen, M.L., Sibarani, M.C., Utoyo, L. and Krofel, M. (2020). Terrestrial mammal community richness and temporal overlap between tigers and other carnivores in Bukit Barisan Selatan National Park, Sumatra. *Animal Biodiversity and Conservation 43: 97-107*. doi: 10.32800/abc.2020.43.0097

Durbin, L.S., Venkataraman, A., Hedges, S. and Duckworth, W. (2004). Dhole *Cuon alpinus*. In: Sillero-Zubiri, C., Hoffmann, M. and Macdonald, D.W. (eds.) *Canids: foxes, wolves, jackals and dogs. Status survey and conservation action plan*. IUCN-SSC Canid Specialist Group. Gland, Switzerland and Cambridge, UK. p. 210-219.

Dsikowitzky, L., A. Damar, S.C.A. Ferse, H.E. Irianto, T.C. Jennerjahn, M.C. Lukas, I. Nordhaus, T. Pohlmann, J. Schwarzbauer, K. Sugama & B. Sumiono (2019). Chapter 21 - Java Island, Indonesia, pp. 459–490. In: Sheppard, C. (ed). World Seas: An Environmental Evaluaton (Second Editon), Volume II: the Indian Ocean to the Pacific. United Kingdom, 912 pp

Badan Pusat Statstk (2020). Statistik Indonesia 2020. Badan Pusat Statstk Indonesia, Jakarta, 748 pp.

Havmøller, L.W., Havmøller, R.W., Worsøe, R., Nawangsari, V.A., Pratiwi, A., Møller, P.R. and Trætholt, C. (2022). Status and conservation of dholes in Indonesia. *Canid Biology and Conservation 24(2):4-12*.

Iyengar, A., Babu, V., Hedges, S., Venkataraman, A., Maclean, N. and Morin, P.A. (2005). Phylogeography, genetic structure, and diversity in the dhole (*Cuon alpinus*). *Molecular Ecology 14: 2281-2297*.
doi: 10.1111/j.1365-294X.2005.02582.x

Kamler, J.F., Songsasen, N., Jenks, K., Srivathsa, A., Sheng, L. and Kunkel, K. (2015). *Cuon alpinus*. The IUCN Red List of Threatened Species 2015 e.T5953A72477893.

Kao, J., Songsasen, N., Ferraz, K. and Traylor-Holzer, K. (eds.) (2020). Range-wide population and habitat viability assessment for the dhole, *Cuon alpinus*. IUCN SSC Conservation Planning Specialist Group, Apple Valley, MN, USA.

Maddox, T., Priatna, D., Gemita, E. and Salampessy, A. (2007). The conservation of tigers and other wildlife in oil palm plantations, Jambi Province, Sumatra, Indonesia. *ZSL Conservation Report No. 7*. London: The Zoological Society of London. 62 pp.

Pudyatmoko, S. (2018). Spatiotemporal inter-predator and predator-prey interactions of mammalian species in a tropical savanna and deciduous forest in Indonesia. *Mammal Research 64: 191-202*. doi: 10.1007/s13364-018- 0391-z

Qodri, A., Utama, I.V., Ferdian, P.R., Dwijayanti, E., Rusdianto, R., Yohanna, Y., Mulyadi, M., Supriatna, N., Hernawati, R.T., Shidiq, F., Encilia, E., Animalesto, G., Sushadi, P.S., Budi, A.S., Rizal, S., Nurhaman, U., Herlambang, A.E.N. and Nurinsiyah, A.S. (2020). Checklist on fauna diversity Gunung Halimun Salak National Park: Cikaniki-Citalahab. *Zoo Indonesia 29: 103-150*. doi: 10.52508/zi.v29i2.4037

Radinal, Kiswayadi, D., Akbar, M., Boyhaqi, T. and Gumay, D. (2019). Monitoring species diversity using camera traps in Ulu Masen ecosystem, Aceh Province, Indonesia. *IOP Conference Series: Earth and Environmental Science 365*: *012064*. doi: 10.1088/1755-1315/365/1/012064

Rahman, D.A., Rianti, P., Muhiban, M., Muhtarom, A., Rahmat, U.M., Santosa, Y. and Aulagnier, S. (2018). Density and spatial partitioning of endangered sympatric Javan leopard (Felidae) and dholes (Canidae) in a tropical forest landscape. *Folia Zoologica 67: 207-219*. doi: 10.25225/fozo.v67.i3- 4.a8.2018

Srivathsa, A., Sharma, S. and Oli, M.K. (2020). Every dog has its prey: range-wide assessment of links between diet patterns, livestock depredation and human interactions for an endangered carnivore. *Science of the Total Environment 714: 136798*. doi: 10.1016/j.scitotenv.2020.136798

Sodhi, N.S., Koh, L.P., Clements, R., Wanger, T.C., Hill, J.K., Hamer, K.C., Clough, Y., Tscharntke, T., Posa, M.R.C. and Lee, T.M. (2010). Conserving Southeast Asian forest biodiversity in human-modified landscapes. *Biological Conservation 143: 2375-2384*. doi: 10.1016/j.biocon.2009.12.0

Sulistyadi, E. (2012). Komunitas Mamalia Besar Gunung Slamet. In: Maryanto, I., Noerdjito, M. and Partomihardjo, T. (eds.) *Ekologi Gunung Slamet*. LIPI Press, anggota Ikapi, Jakarta. P. 121-134.

Sunarto, S., Kelly, M., Parakkasi, K. and Hutajulu, M. (2015). Cat coexistence in central Sumatra: ecological characteristics, spatial and temporal overlap, and implications for management. *Journal of Zoology 296: 104-115*. doi: 10.1111/jzo.12218

Widodo, F.A., Sunarto, D.H., Gunawan, N.F., Sukmantoro, W., Zulfahmi, E.S. and Adzan, G. (2020). Preliminary assessment of abundance and distribution of Dholes *Cuon alpinus* in Rimbang Baling and Tesso Nilo landscapes, Sumatra. *Raffles Bulletin of Zoology 68: 387-395*.

Zhang, H. and Chen, L. (2011). The complete mitochondrial genome of dhole *Cuon alpinus*: phylogenetic analysis and dating evolutionary divergence within Canidae. *Molecular Biology Reports 38: 1651-1660*. doi: 10.1007 /s11033-010-0276-y

InJAST
Volume 4, Number 1, April 2023
Pages: 33-38

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.7171

Possibility of municipal waste management with Refuse-Derived Fuel (RDF) mixed paper and garden in Depok City

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Submitted 5 February 2023; Accepted 1 April 2023

ABSTRACT

Paper and garden waste are among the various types of rubbish commonly encountered in urban areas in Indonesia, including the city of Depok. Notably, not all paper waste can be recycled by garbage collectors into new products. In addition, garden waste is also garbage, one of the wastes produced daily from gardening activities. This study analyzed the potential for reducing paper and garden waste using as Refuse-Derived Fuel or RDF in Depok City. This study analyzes the quality of RDF based on the parameters of water content, ash content, density, and calorific value resulting from the material substitution. The results were analyzed using the multicollinearity and Kepner-Tregoe Decision Analysis (KTDA). The results of the multicollinearity test showed that the ash and water content could reduce the calorific value of RDF mixed with paper and garden waste. The addition of garden waste composition can increase the calorific value. Based on the results of decision analysis using KTDA, it shows that the variation of the mixture of 75% paper waste and 25% wood waste has the most prominent points compared to other variations. Material Flow Analysis (MFA) utilization of this waste can reduce the generation of paper and garden waste by 3.5% and 12.3%, respectively.

ABSTRAK

Sampah kertas dan kebun adalah beberapa jenis sampah yang biasa ditemukan di perkotaan di Indonesia, termasuk kota Depok. Perlu dicatat, tidak semua sampah kertas dapat didaur ulang oleh pemulung menjadi produk baru. Selain itu, sampah kebun juga merupakan salah satu sampah yang dihasilkan sehari-hari dari kegiatan berkebun. Kajian ini menganalisis potensi pengurangan sampah kertas dan kebun dengan menggunakan Refuse-Derived Fuel atau RDF di Kota Depok. Penelitian ini menganalisis kualitas RDF berdasarkan parameter kadar air, kadar abu, berat jenis, dan nilai kalor hasil substitusi bahan. Hasil penelitian dianalisis menggunakan multikolinearitas dan Analisis Keputusan Kepner-Tregoe (KTDA). Hasil uji multikolinearitas menunjukkan bahwa kadar abu dan air dapat menurunkan nilai kalor RDF yang bercampur dengan kertas dan sampah kebun. Penambahan komposisi sampah kebun dapat meningkatkan nilai kalor. Berdasarkan hasil analisis keputusan menggunakan KTDA menunjukkan bahwa variasi campuran 75% limbah kertas dan 25% limbah kayu memiliki poin paling menonjol dibandingkan variasi lainnya. Pemanfaatan Material Flow Analysis (MFA) limbah ini dapat mengurangi timbulan limbah kertas dan kebun masing-masing sebesar 3,5% dan 12,3%.

Keywords: *garden waste, KTDA, paper waste, RDF, waste to energy*

INTRODUCTION

Each individual generates waste, so an increase in waste is proportional to the exponential growth of the population (M. Sari et al., 2022). However, if viewed from the other side, the increase in waste can be a business opportunity. Numerous paper waste includes HVS paper (computer paper and writing paper), kraft paper, cardboard, plastic-coated paper, and more. Different activities produce different types of paper waste (Abdel-Shafy & Mansour, 2018; Geueke et al., 2018; Suryawan, Fauziah, et al., 2022). Small industries usually accept paper waste as paper art materials such as artistic boxes, greeting cards, souvenirs, and others (Twede et al., 2015). Meanwhile, large industries recycle paper waste into pulp (paper raw material). Unfortunately, paper waste as one of the raw materials for the recycling industry has not been managed optimally so only 70% can be reused or recycled (Wahyono, 2001). In fact, the amount of paper waste generated in Indonesia reach about 12.77% of the total amount of waste (Kementerian Lingkungan Hidup dan Kehutanan, 2021).

Degradable garden waste can be used as compost. Although not all of the waste can be processed into compost, waste such as wood can be used as an alternative fuel, such as refuse-reived fuel (RDF). RDF results from a waste separation process between flammable and non-combustible waste fractions such as metal and glass (Cheremisinoff, 2003; Suryawan, Septiariva, et al., 2022). Sorting RDF should be separated from thermal treatment because the process produces fuel and produces organic fractions that can form raw materials for biological processing. RDF

consists primarily of paper, wood, and plastic, with higher energy content than unsorted municipal waste (Brás et al., 2020). Using RDF as a fuel provides advantages such as high calorific value, homogeneity of physical-chemical composition, ease of storage, handling, and transportation. Fewer pollutant emissions are produced, and reduced air is required for the combustion RDF process (Bosmans et al., 2013; Suryawan et al., 2021).

RDF is commonly used in countries with advanced waste management in cement and power generation industries. In a cement kiln, combustion occurs at a very high flame temperature of about 1450 °C and a relatively long residence time (Nathan et al., 2006). Therefore, based on technical and environmental considerations, there is an upper limit for the total consumption of materials. The energy generated is calculated based on the lower heating value (Lower Heating Value/LLV) assumed for energy efficiency. Internal energy use is 18% and 15% of the electrical energy generated. Europe, America, and Japan have applied RDF technology (Chen et al., 2011; Fu et al., 2005; Kupka et al., 2008; M. M. Sari et al., 2023). Waste processed into RDF can be assessed based on calorific value, moisture content, volatile content, ash content, chlorine content, and several other parameters.

Several other parameters strongly influence the calorific value of the RDF manufacturing process. Therefore, it is necessary to test the correlation between the variables in mixing paper and garden waste to achieve the optimum heating value. The current application of RDF has also been carried out to reduce municipal waste generation, including the Depok. Depok City also has paper and garden waste characteristics that must be reduced (Zahra et al., 2022). This research analyzes the potential utilization of paper and garden waste substitution as RDF.

METHODS

This study uses a variation of 25% for each addition to the composition of paper and garden waste to manufacture RDF pellets. RDF's quality was measured by calculating the moisture and ash content using the gravimetric principle. Meanwhile, density was measured using an automatic density analyzer connected to an ultrapyc-quantachrome power cable, and the hydrogen gas regulator was opened to a pressure of 18 psi. Finally, the calorific value is measured using the bomb calorimeter principle.

Before carrying out the decision analysis test, statistical analysis was carried out on the composition of paper, garden, moisture content, ash content, and density on the calorific value. A multicollinearity test is a situation that shows a strong correlation or relationship between two or more independent variables in a multiple regression model. The multicollinearity test in this study used a linear equation with the SPSS program.

Kepner-Tregoe Decision Analysis (KTDA) is a method to provide the best solution from several alternatives (Moseley et al., 2008). This study used the KTDA method to determine the best quality of RDF pellets among the five compositions worthy of being used as raw material for RDF pellets at TPSS Merdeka 3. The test results of the five RDF pellets had values that were not much difference between each variation, so the analysis was needed. There are two categories of assessment, namely must and wants. The must category is carried out at the initial stage of the evaluation, namely scoring in the form of Go and No Go. The Go assessment meets the criteria to be achieved, while the No Go assessment does not meet the criteria to be completed. The wants category is assessed after evaluating the must criteria by giving weight and rating.

This study analyzes the various compositions of paper waste and garden potential raw materials for RDF pellets. Therefore, RDF pellets from various compositions of paper waste and garden must be compared with applicable standards to determine their quality and suitability as fuel. These standards are density standards and RDF quality standards from several countries. The density standard used in this study conforms to the pellet quality standards from Austria, Sweden, America, and France (Bantacut et al., 2013). The quality standards of RDF used in this study follow Italian, Finnish, English, and Indocement standards. The use of density standards and quality standards of RDF pellets is to determine the efficiency of combustion performance of pellets. The standard values that apply to each parameter can be seen in Table 1 and Table 2.

The pellet density and RDF quality standards are compared with the laboratory results to determine their conformity with predetermined standards. The five RDF pellets analyzed the must criteria (mandatory to be met). Furthermore, an assessment of the wants category was carried out to evaluate RDF pellets adjusted to the selected standard, namely in terms of moisture content, ash content, and calorific value prevailing in the Indonesian cement industry, one of which has been implemented by Indocement. In Table 3, an assessment

Table 1. RDF Quality parameter standards

Parameter	Standard			
	Italy*	Finland*	UK*	Indocement**
Calorific Value	15	13-16	18,7	12.56
Water content	Max 25	25-35	7-8	Max 20
Ash Level	20	5-10	12	10

(Source: *Gendebien, 2003; **Qonitan et al., 2021)

Table 2. Standard of pellet density parameter

Parameters	Standard			
	Austria	Sweden	USA	England
Density	1120	600	640	1150

(Source: Bantacut et al., 2013)

of the wants category is carried out by giving a weighting value consisting of weight and rating values. In Table 3, the weight assessment is the level of importance of the criteria, where the higher the weight value, the more important the criteria. The following is a description of the assessment on weight:

- 1-2 (Not important): These parameters do not affect the quality of the RDF, so they do not affect the efficiency of combustion performance.
- 3-4 (Less important): These parameters have little effect on RDF quality but do not affect combustion efficiency or performance.
- 5-6 (Enough): These parameters influence the quality of the RDF and possibly affect combustion efficiency or performance.
- 7-8 (Important): These parameters significantly influence the quality of the RDF and can affect combustion efficiency and performance.
- 9-10 (Very important): These parameters very significantly influence the quality of the RDF and can affect combustion efficiency and performance.

Table 3. Value of weight and rating on wants assessment

Rating	1-2	3-4	5-6	7-8	9-10
Weight (How important)	Tends to be unimportant	Not too important	Enough	Important	Very important
Rating (Fullfilment rate)	Very less	Not enough	Enough	Good	Very good

RESULTS AND DISCUSSION

Waste that can be used as raw material for RDF is combustible waste, including paper and garden waste. The main parameters of the characteristics of waste as raw material for RDF include water content, ash, density, and calorific value (Białowiec et al., 2017; Sarwono et al., 2021; Suryawan, Fauziah et al., 2022; Ulhasanah et al., 2022). Moisture content and calorific value are needed to evaluate alternative processes and recovery systems that can be carried out on solid waste (Kathirvale et al., 2004). Therefore, parameter analysis on paper and garden waste carried out is water content and calorific value to determine its potential as raw material for RDF pellets. Table 4 shows the test results of the RDF's quality characteristics from the variations used.

Table 4. Results of RDF quality laboratory tests

ID	Paper (by w/w)	Garden (by w/w)	Result			
			Water content (%)	Ash content (%)	Density (kg/m^3)	Caloric value (MJ/kg)
K-100%	100%	0%	10.1	9.9	2247	13.1
K-75%	75%	25%	5.8	7.7	2009	16.3
K-50%	50%	50%	9.4	7.1	2637	17.1
K-25%	25%	75%	8.5	6.9	2048	18.3
K-0%	0%	100%	15.3	4.5	1971	19.0

Pearson correlation measures the strength and direction of a linear relationship between two variables. It can be seen that the relationship between the variable paper composition and ash content has a very strong negative relationship with caloric value. At the same time, the provision of garden waste has a very strong positive correlation value in increasing the calorific value of RDF Table 5).

Table 5. Pearson correlation of RDF quality parameter measurement results

Variable	Caloric value (MJ/kg)	Paper (by w/w)	Garden (by w/w)	Water content (%) (by w/w)	Ash content (%) (by w/w)	Density (kg/m^3)
Caloric value (MJ/kg)	1	-0.951	0.951	0.342	-0.936	-0.282
Paper (by w/w)	**-0.951**	1	-1	-0.594	0.948	0.295
Garden (by w/w)	**0.951**	-1	1	0.594	-0.948	-0.295
Water content (%) (by w/w)	0.342	-0.594	0.594	1	-0.586	-0.114
Ash content (%) (by w/w)	**-0.936**	0.948	-0.948	-0.586	1	0.304
Density (kg/m^3)	-0.282	0.295	-0.295	-0.114	0.304	1

Very strong multicollinearity was found in this study (R^2 0.999) (Table 6). There was a strong correlation between the independent variables (X) included in the determination of the calorific value in this study. However, water content and ash content have negative coefficients, which will reduce the heat content in RDF manufacture. Meanwhile, the addition of garden waste will increase the calorific value.

Table 6. Multilinear equations in determining the calorific value of a mixture of garden and paper waste

Model	Unstandardized coefficients
(Constant)	19.977
Garden (by w/w)	0.045
Water content (by w/w)	-0.242
Ash content (%) (by w/w)	-0.516
Density (kg/m^3)	0
R^2	0.999

*Excluded variable composition of paper (%)

The main criteria that must be met in most analyses are that the five variations of pellets must meet the RDF standard provisions. Based on Table 4, pellets K-75%, K-50%, K-25%, and K-0% have completed the applicable RDF standard provisions to be considered for use as fuel. On the other hand, the K-100% pellet did not meet the RDF standard, so no further evaluation was carried out on the wants analysis in KTDA. Furthermore, the four variations of RDF pellets were assessed in the wants category to evaluate RDF pellets adjusted to the selected standard: moisture content, ash content, and calorific value parameters. RDF in this study is applicable in the Indonesian cement industry, one of which has been implemented by Indocement. Therefore, the four variations of RDF pellets in this study have parameters that best match the RDF criteria used by the cement industry. Because the cement industry in Indonesia has adapted to the characteristics of waste and waste collection systems in Indonesia, the selection of cement industry standards is also due to a work plan. Therefore, the quality of the five RDF pellets in this study can be used as a pilot for RDF pellets by the cement industry. Based on the assessment criteria in the must and wants categories, the calculation results are obtained in Table 7.

The calculation results show that K-75% has the most significant total value of 171 because it has a lower water content than others (Table 7). The low water content value will facilitate handling operations so that the quality of combustion performance becomes more effective and efficient and benefits the company. Based on the recapitulation results of alternative evaluations of various variations of RDF pellets using the KTDA method, the selected variation was obtained from pellets K-75% with a mixture of 75% paper and 25% paper garden.

Table 7. Calculation of decision analysis with the KTDA method on the best variation

Weighting		RDF							
No	Must	K-100%	K-75%		K-50%		K-25%		K-0%	
1	Meet standard quality	NO, GO	GO		GO		GO		GO	
Wants	Weight		Rating	Score	Rating	Score	Rating	Score	Rating	Score
1	9	Calculations were not carried out because K-100% did not meet the standard quality criteria	9	81	6	54	6	54	2	18
2	7		6	42	6	42	6	42	8	56
3	8		6	48	6	48	6	48	7	56
Total			171		144		144		130	

The waste processing capacity that can be carried out by TPSS Merdeka 3 every day is 3 tons, so if 75% paper and 25% garden are selected, TPSS Merdeka 3 can process 75% paper waste from the total capacity of 2.25 tons/da and garden of 0.75 tons/day. Then the total waste generated in Depok City is 1070 tons/day. The composition of paper waste is 6%, which is the third-largest component after food waste and plastic. The following are the results of calculating the potential for reducing paper waste and gardens in Depok City using selected RDF pellet variations, namely 75% paper and 25%. Details of the calculations can be seen in Table 8. So based on the results of the above calculations, the potential for paper waste reduction is 3.5%, and garden waste is 12.3%.

Material Flow Analysis (MFA) of the waste utilization can be seen in Figure 1. Applying this RDF can reduce 3.5% of paper waste and 12.3% of garden waste in Depok City.

Table 8. Calculation of waste reduction potential for RDF mixed garden and paper waste

Parameters	Value
Capacity of MRF	3 tons/day
The amount of paper waste and litter that can be processed at the MRF	• Paper waste: 75% (Kementerian Lingkungan Hidup dan Kehutanan, 2021) x 3 Tons = 2.25 tons/day • Garden waste: 25% (Kementerian Lingkungan Hidup dan Kehutanan, 2021) x 3 Ton = 0.75 ton/day
Total waste generation in Depok City	1,070 ton/day (Kementerian Lingkungan Hidup dan Kehutanan, 2021)
Amount of paper waste in Depok City	6% x 1070 ton/day = 64.2 ton/day
Paper waste reduction potential in Depok City	$\frac{2{,}25\ ton/day}{64{,}2\ ton/day}\ x\ 100\% = 3.5\%$
Amount of garden waste in Depok City	0.57% x 1070 ton/day = 6.09 ton/day
Garden waste reduction potential in Depok City	$\frac{0{,}75\ ton/day}{6{,}09\ ton/day}\ x\ 100\% = 12{,}3\%$

Figure 1. Material flow of paper and garden waste utilization to RDF in Depok City

CONCLUSION

Based on the variation of mixing, 75% paper waste and 25% wood waste have the most prominent points in mixing waste. Based on Material Flow Analysis (MFA), the utilization of this waste can reduce the generation of paper waste and garden waste by 3.5% and 12.3%, respectively.

REFERENCES

Abdel-Shafy, H. I., & Mansour, M. S. M. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian Journal of Petroleum, 27(4), 1275–1290*. https://doi.org/10.1016/j.ejpe.2018.07.003

Bantacut, T., Hendra, D., & Nurwigha, R. (2013). The Quality of Biopellet from Combination of Palm Shell Charcoal and Palm Fiber. *Jurnal Teknologi Industri Pertanian, 23(1), 1–12*. http://citeseerx.ist.psu.edu/viewdoc/downlad?doi= 10.1.1.826.371&rep=rep1&type=pdf

Białowiec, A., Pulka, J., Stępień, P., Manczarski, P., & Gołaszewski, J. (2017). The RDF/SRF torrefaction: An effect of temperature on characterization of the product – Carbonized Refuse Derived Fuel. *Waste Management, 70, 91–100*. https://doi.org/10.1016/j.wasman.2017.09.020

Bosmans, A., Vanderreydt, I., Geysen, D., & Helsen, L. (2013). The crucial role of Waste-to-Energy technologies in enhanced landfill mining: A technology review. *Journal of Cleaner Production, 55, 10–23*. https://doi.org/10.1016/j.jclepro.2012.05.032

Brás, I., Silva, E., & de Lemos, L. T. (2020). Feasibility of using municipal solid wastes rejected fractions as fuel in a biomass power plant. *Environment Protection Engineering, 46(2), 53–62*. https://doi.org/10.37190/epe200204

Chen, W.-S., Chang, F.-C., Shen, Y.-H., & Tsai, M.-S. (2011). The characteristics of organic sludge/sawdust-derived fuel. *Bioresource Technology, 102(9), 5406–5410*. https://doi.org/10.1016/j.biortech.2010.11.007

Cheremisinoff, N. P. (2003). Handbook of solid waste management and waste minimization technologies. In *Chemical Engineer* (Issue 744). https://doi.org/10.1016/b978-0-7506-7507-9.x5000-1

Fu, Z.-M., Li, X.-R., & Koseki, H. (2005). Heat generation of refuse derived fuel with water. *Journal of Loss Prevention in the Process Industries, 18(1), 27–33*. https://doi.org/10.1016/j.jlp.2004.09.001

Gendebien, A. (2003). Refuse derived fuel, current practice and perspectives. *WRc Ref*: CO5087-4.

Geueke, B., Groh, K., & Muncke, J. (2018). Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials. *Journal of Cleaner Production, 193, 491–505*. https://doi.org/10.1016/j.jclepro.2018.05.005

Kathirvale, S., Muhd Yunus, M. N., Sopian, K., & Samsuddin, A. H. (2004). Energy potential from municipal solid waste in Malaysia. *Renewable Energy, 29(4), 559–567*. https://doi.org/10.1016/j.renene.2003.09.003

Kementerian Lingkungan Hidup dan Kehutanan. (2021). *Sistem informasi Pengelolaan Sampah Nasional*. http://sipsn.menlhk.go.id

Kupka, T., Mancini, M., Irmer, M., & Weber, R. (2008). Investigation of ash deposit formation during co-firing of coal with sewage sludge, sawdust and refuse derived fuel. *Fuel, 87(12), 2824–2837*. https://doi.org/10.1016/j.fuel.2008.01.024

Moseley, J. D., Brown, D., Firkin, C. R., Jenkin, S. L., Patel, B., & Snape, E. W. (2008). Kepner-Tregoe decision analysis as a tool to aid route selection. Part 2. Application to AZD7545, a PDK inhibitor. *Organic Process Research and Development, 12(6), 1044–1059*. https://doi.org/10.1021/op800033c

Nathan, G. J., Mi, J., Alwahabi, Z. T., Newbold, G. J. R., & Nobes, D. S. (2006). Impacts of a jet's exit flow pattern on mixing and combustion performance. *Progress in Energy and Combustion Science, 32(5), 496–538*. https://doi.org/10.1016/j.pecs.2006.07.002

Qonitan, F. D., Suryawan, I. W. K., & Rahman, A. (2021). Overview of Municipal Solid Waste Generation and Energy Utilization Potential in Major Cities of Indonesia. *Journal of Physics: Conference Series, 1858(1)*. https://doi.org/10.1088/1742-6596/1858/1/012064

Sari, M. M., Septiariva, I. Y., Fauziah, E. N., Ummatin, K. K., Arifianti, Q. A. M. O., Faria, N., Lim, J.-W., & Suryawan, I. W. K. (2023). Prediction of recovery energy from ultimate analysis of waste generation in Depok City, Indonesia. *International Journal of Electrical and Computer Engineering (IJECE), 13(1), 1*. https://doi.org/10.11591/ijece.v13i1.pp1-8

Sari, M., Suryawan, I. W. K., Ramadan, B. S., Septiariva, I. Y., & Notodarmojo, S. (2022). Marine Debris Management in the Parangtritis Beach Tourism Area , Yogyakarta During Covid-19 Pandemic. *Nature Environment and Pollution Technology, 21(3), 1183–1190*.

Sarwono, A., Septiariva, I. Y., Qonitan, F. D., Zahra, N. L., Sari, N. K., Fauziah, E. N., Ummatin, K. K., Amoa, Q., Faria, N., Wei, L. J., & Suryawan, I. W. K. (2021). Refuse Derived Fuel for Energy Recovery by Thermal Processes. A Case Study in Depok City, Indonesia. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 88(1), 12–23*. https://doi.org/10.37934/arfmts.88.1.1223

Suryawan, I. W. K., Fauziah, E. N., Septiariva, I. Y., Ramadan, S., Sari, M. M., Ummatin, K. K., & Lim, J. (2022). Pelletizing of Various Municipal Solid Waste : Effect of Hardness and Density into Caloric Value. *Ecological Engineering & Environmental Technology (EEET), 23(2), 122–128*. https://doi.org/https://doi.org/10.12912/27197050/145825

Suryawan, I. W. K., Septiariva, I. Y., Fauziah, E. N., Ramadan, B. S., Qonitan, F. D., Zahra, N. L., Sarwono, A., Sari, M. M., Ummatin, K. K., & Wei, L. J. (2022). Municipal solid waste to energy : palletization of paper and garden waste into refuse derived fuel. *Journal of Ecological Engineering, 23(4), 64–74*.

Suryawan, I. W. K., Wijaya, I. M. W., Sari, N. K., & Yenis, I. (2021). Potential of Energy Municipal Solid Waste (MSW) to Become Refuse Derived Fuel (RDF) in Bali Province , Indonesia. *Jurnal Bahan Alam Terbarukan, 10(200)*.

Twede, D., Selke, S. E. M., Kamdem, D.-P., & Pira, S. (2015). SECOND EDITION CARTONS, CRATES and CORRUGATED BOARD Handbook of Paper and Wood Packaging Technology David Shires, BA (Hons). *DEStech Publications*.

Ulhasanah, N., Widanarko, D. U. F., Erlingga, F. A., Fitrah, E. B., Aulia, W., Sari, D. M., & Rahman, A. (2022). Design of Hazardous Waste Storage Area for Fecal Sludge Briquettes by Waste Impoundment in Indonesia. *Journal of Sustainable Infrastructure, 1(1 SE-Articles), 35–48*. file://jsi.universitaspertamina.ac.id/index.php/jsi/article/view/5

Wahyono, S. (2001). Pengelolaan Sampah Kertas di Indonesia. *Jurnal Teknologi Lingkungan, 2(3), 276–280*.

Zahra, N. L., Septiariva, I. Y., Sarwono, A., Qonitan, F. D., Sari, M. M., Gaina, P. C., Ummatin, K. K., Arifianti, Q. A. M. O., Faria, N., Lim, J.-W., Suhardono, S., & Suryawan, I. W. K. (2022). Substitution garden and polyethylene terephthalate (PET) plastic waste as refused derived fuel (RDF). *International Journal of Renewable Energy Development, 11(2), 523–532*. https://doi.org/10.14710/ijred.2022.44328

InJAST
Volume 4, Number 1, April 2023
Pages: 39-45

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.7280

The re-discovery in Sumatra of a rarely seen moth, *Heterosphecia tawonoides*, and its identification using citizen science platform iNaturalist

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Submitted 6 March 2023; Accepted 19 April 2023

ABSTRACT

Traditional methods of species identification involve the collection and killing of specimens. The associated costs and expertise required are prohibitory. In this paper we describe the first documented record of *Heterosphecia tawonoides* in its natural habitat in Sumatra since 1887, reporting its identification using photographs uploaded to the citizen science platform iNaturalist. Our findings add valuable information to the small body of work on this species and demonstrate the importance of having freely available high-quality tools such as iNaturalist without which this important record would not have been reported and the observation of this rarely seen moth species in Sumatra would have remained unknown.

ABSTRAK

Metode identifikasi spesies tradisional melibatkan pengumpulan dan pembunuhan spesimen. Biaya terkait dan keahlian yang dibutuhkan adalah berupa larangan. Dalam artikel ini kami menjelaskan catatan pertama yang terdokumentasikan dari *Heterosphecia tawonoides* di habitat alaminya di Sumatera sejak 1887, melaporkan identifikasinya menggunakan foto yang diunggah ke platform ilmiah iNaturalist. Temuan kami menambah informasi berharga untuk sejumlah kecil pekerjaan pada spesies ini dan menunjukkan pentingnya memiliki alat berkualitas tinggi yang tersedia secara gratis seperti iNaturalist, tanpanya catatan penting ini tidak akan dilaporkan dan pengamatan spesies ngengat yang jarang terlihat ini di Sumatera akan tetap tidak diketahui.

Keywords: *biodiversity, citizen science, iNaturalist, rediscovery, species identificationt*

INTRODUCTION

Biodiversity is in crisis with estimates that over 1 million plant and animal species are threatened with extinction (Estrada et al., 2017). Accurate biological species identification is essential and can be used to inform the management and conservation of biodiversity (Austen et al., 2016; Hope et al., 2018; Kürzel et al., 2022). Traditionally species have been identified by describing morphological traits from biological specimens collected in the field. Such 'voucher specimens' are a verifiable representative of a species, often used to describe new species and usually deposited in a curated collection typically of a museum or institution (Ajmal Ali et al., 2014; Turney et al., 2015). The necessity of killing specimens to study them is being called into question and is often subject to controversy (Minteer et al., 2014; Waeber et al., 2017). There are limitations associated with traditional species level identification methods: identification of insects is expensive, time consuming, requires expert knowledge, including of behavioural phenotypes and can be problematic due to the vast number of species (Valan et al., 2019).

Alternative methods of identification are available and include techniques such as DNA sequencing of biopsy or other samples, computer vision/machine learning and behavioural observations (Ajmal Ali et al., 2014; Perring et al 1993; Ronque et al 2016; Spiesman et al., 2021). Such methods might appear supplementary, as voucher specimen collection still seems to be the reference method and museum collections have been recently described as making innumerable contributions to science and society that save governments and taxpayers millions of dollars (Bakker et al., 2020; Suarez & Tsutsui, 2004; Turney et al., 2015).

Citizen science is increasingly used to contribute to scientific research and species identification with databases such as iNaturalist (www.inaturalist.org) and eBird (www.ebird.org) contributing massive amounts of biodiversity data that could not be sourced in any other way (Koch et al., 2022; Sun et al., 2021). iNaturalist, a joint initiative of the California Academy of Sciences and the National Geographic Society, is a freely available, online open access platform that allows users to upload biodiversity photographs, using machine learning methods to automatically suggest an identification which is then verified by community members (iNaturalist 2023 a). Importantly, submissions are curated using open

source software and submitted under a Creative Commons license allowing reuse of data (iNaturalist b, c 2022). As of 20th February 2023 iNaturalist has 127,247,966 observations, 415,739 species, 289,590 identifiers and 2,521,464 observers (iNaturalist 2022 d). The designation 'research grade' to an observation requires a photo, date, coordinates and agreement from the community on the taxon which results in high quality datasets (iNaturalist e 2022). As of 12th November 2022 the Global Biodiversity Information Facility website (www.GBIF.org) lists the iNaturalist dataset as having 53,049,459 research grade occurrences and 2,966 citations (GBIF 2022 a).

Clearwing moths (Lepidoptera: Sessidae) are known for their Batesian mimicry of Hymenoptera species and worldwide there are 160 genera with 1452 recognized species (Pühringer 2022). Tropical clearwing moths are rarely encountered in nature and little is known about their behaviour, distribution and ecology and photographic documentation is extremely uncommon (Gorbunov & Severtsov, 2015; M. Skowron Volponi, 2020). Heterosphecia is a genus of moths in the family Sesiidae found in Borneo, Sumatra and South India. There are eight known species with few records, and their conservation status is unknown (GBIF 2022 b; M. A. Skowron Volponi & Volponi, 2017). *Heterosphecia tawonoides* was first described in 2003 using a specimen collected from an unknown location in Sumatra in 1887 (Kallies, 2003). It was observed and filmed for the first time in its natural habitat in Malaysia 2013 exhibiting puddling behaviour and bee mimicry which are only possible to see on live specimens. (M. A. Skowron Volponi & Volponi, 2017).

In this paper we present the first documented record of *H. tawonoides* in its natural habitat in Sumatra since 1887, reporting its identification using iNaturalist.

METHODS

Observations of *H. tawonoides* were made near Bukit Lawang, North Sumatra on the 20th May 2015 and photographed using Canon EOS 2000d mounted with a 55-250 mm Canon lens. Observations were uploaded onto iNaturalist on 24th February 2022.

Study Area

Bukit Lawang is a tourist focused village located within the Langkat district of north Sumatra (03°32.770'N, 098°07.000'E) on the eastern edge of the Gunung Leuser National Park, adjacent to the Bohorok river. Orangutan are flagship species for conservation of their forest habitat and Bukit Lawang has a very long affiliation with orangutan tourism as well as its associated problems (Molyneaux et al., 2021; Walpole & Leader-Williams, 2002). Whilst Sumatra is a biodiversity hotspot and Bukit Lawang gives relatively easy access to a wide variety of habitats the tourism in this area is heavily reliant on orangutan and little attention is given to promoting awareness of any other species (Molyneaux 2022).

RESULT AND DISCUSSION

A single specimen of *H. tawonoides* was observed and photographed on the cement block path (Figure 1) of a remote house on the border of Gunung Leuser National Park close to the tourist village of Bukit Lawang. The path is next to an ornamental fish pool but over 100 m from the large, fast flowing Bohorok river. The surrounding habitat (Figure 2) is an overgrown mix of both primary and secondary forest and small scale rubber and palm oil plantations. 6 photographs (Figure 3 a-f) were taken between 13:30-13:35 on the 20th May 2015 and show the moth puddling on the edges of the cement block path.

Figure 1. Cement block path of remote house near Bukit Lawang village.

Figure 2. Surrounding habitat of the remote house.

The first 4 photographs (Figure 3 a-d) were uploaded onto iNaturalist on the 24th February 2022 (iNaturalist, 2022) and were submitted with a provisional identification of "genus Epicharis, apine bee". Over a period of several weeks community members suggested refinements of the identification arriving at the suggestion of *H. tawonoides* on 13th March 2022 which was confirmed by user @kallies (who first described the species in 2003) and by 5 other community members (Kallies, 2003; iNaturalist 2022 d). It is the first and currently the only recording of this species on iNaturalist and is a research grade observation. (see Table 1 Species identification sequence on iNaturalist). A comparison with the holotype (Kallies, 2003) and with descriptions of its observation in Malaysia (Skowron Volponi & Volponi, 2017) shows that our observation also has the novel morphological features only visible on a live specimen – blue wing sheen, blue and white hair like scales on all tibia, elongated white hair like scales on hind tibia. (see Table 2 Comparison of documented records of *H. tawonoides*).

Figure 3. a-f *H. tawonoides* observed and photographed on 20th May 2015 near Bukit Lawang village, North Sumatra, Indonesia.

Table 1. Species identification sequence on iNaturalist

Photographs uploaded on 24 /2 /2022	
24/02/2022	Genus Epicharis - a member of Apine Bees (**withdrawn**)
25/02/2022	Kupu-Kupu dan Ngengat - Order Lepidoptera
25/02/2022	Picture-winged Leaf Moths (**withdrawn**) - Superfamily Thyridoidea
27/02/2022	Clearwing Moths - Family Sesiidae
13/03/2022	Genus Heterosphecia -a member of Clearwing Moths -Family Sesiidae
Species identified and confirmed 13/3/2022	
Oriental Blue Clearwing *Heterosphecia tawonoides*	

Here we show that high quality photographic records can be used to identify a poorly known and rarely seen species of moth using iNaturalist in the field. Having access to a large network which included an 'expert enabled rapid identification of this species of moth that has not been recorded in Sumatra since 1887. Our findings represent the first ever record of observation of this species in its natural habitat in Sumatra and only the 3rd published record.

The traditional method of obtaining voucher specimens for species identification is subject to controversy with two recent examples relating to a non-endangered goliath bird eating spider and a rarely seen moustached kingfisher. Both species were collected during large biodiversity surveys and the spider was one of 857 voucher specimens!

Both instances received a lot of negative criticism prompting the collectors to publish detailed accounts of their reasons for collecting the specimens. (Naskrecki 2014; Boroff 2015; Filardi 2015; Silber 2015). Scientists have long been polarized about the use of voucher specimens (Funk et al., 2018; Marshall & Evenhuis, 2015) The suggestion that alternative methods of identification should be used in relation to threatened or rediscovered species (Minteer et al., 2014) proved controversial and elicited strong response in support of voucher specimens (Krell & Wheeler, 2014; Rocha et al., 2014). Digital photography, geolocation, open access databases and widespread internet access are enabling wider engagement with the process of collecting and curating primary biodiversity data and pushing access beyond that of professional academic researchers. Species ARE nowadays being identified without voucher specimens and it is recommended that traditional taxonomic scientists engage with this ever expanding network and community (Marshall, 2018; Marshall & Evenhuis, 2015; Wilson et al., 2020).

Table 2. Comparison of documented records of *H.tawonoides*

	Kallies 2003 (holotype)	Volponi 2017	This paper
Date of publication / uploading	2003	2017	24-2-2022
Date of specimen /observation	1887	2013, 2016, 2017	20-5-2015
Country	Sumatra	Malaysia	Sumatra
Habitat	not detailed	primary lowland forest	cement path next to primary/secondary rainforest
Stored location of specimen	Natural history museum, Vienna	British museum of natural history and private collection	n/a
Observed behaviour	not detailed	Mud-puddling on sandy/pebble river bank	puddling on a cement block path
Id methods	not detailed	Photo, pinned for morphological analysis, dissection of male genitalia, DNA barcoding	Photo, iNaturalist
Novel morphological observations	not detailed	strong blue sheen on wings	Yes
		characterisitic tufts of hair like scales on all tibia longest on hind legs, alternate shiny blue and white colouration	Yes
		strongly elongated, creamy white hair like scales of hind tibia extend interiorly over folded wings and abdomen in natural resting position	Yes
		resemblance to bees	Yes

With our account we show that it has not been necessary to kill and remove the specimen to a museum or collection to identify it. Our observations show the moth exhibiting puddling behaviour and displaying novel morphological features which are consistent with those described in the only other documented record of this species in its natural habitat (Skowron Volponi & Volponi, 2017). Sessiids have been noted to visit river banks, streams, puddles and wet soil remaining after drying out of flowing water (Gorbunov & Severtsov, 2015; Skowron Volponi, 2020, 2022). A potentially significant difference is that in our observations the moth was puddling on an artificial cement block path far from natural flowing water (but close to a small artificial fish pool) whereas Volponi (2017) documents *H. tawonoides* puddling on a leaf on the riverbank of a lowland dipterocarp forest.

Thus we add valuable information to the small body of work on this species and genus. We demonstrate the importance of having an open access database and vast community network as without it this important record would not have been reported and the observation of this rarely seen moth species in Sumatra would have remained unknown.

CONCLUSION

The debate around specimen collection will doubtless continue with strong ethical and conservation concerns being expressed and alternatives proposed (Russo et al 2017). Citizen scientist platforms such as iNaturalist continue to generate vast amounts of increasingly important data with significant contributions, such as rediscovery of species and previously undocumented behaviours, the value of which taxonomic science cannot ignore. (Callaghan et al 2022, Fraisl et al 2022). Citizen science plays a crucial part in species identification and the documentation of biodiversity (Koo et al., 2022; Mueller et al., 2019; Wilson et al., 2020).

Implications for conservation

Information about the distribution of Lepidoptera in Indonesia and particularly Sumatra is limited (Iqbal et al., 2022). Whilst long term field studies and surveys for clearwing moths in this area may be desirable the funds and expertise to carry them out are scarce. Our rediscovery and documenting of a rarely seen moth species, *H. tawonoides*, using noninvasive, easily accessible and affordable yet high quality methods could be used to highlight the importance and conservation of its forest edge habitat. It could be used as an alternative flagship species, to promote biodiversity awareness in Bukit Lawang, an area that relies heavily on tourism focused around orangutan (Molyneaux 2022). We strongly encourage travelers, visitors, residents, scientists and naturalists to take photos of the wildlife they see and upload their observations to iNaturalist in order that biodiversity can be documented and the information accessible to all.

ACKNOWLEDGEMENT

I would like to thank Vincent Nijman for his helpful comments regarding the concept of this manuscript. I also thank Andrew Marsh (ORCID ID https://orcid.org/0000-0001-8845-3562) for, guidance and comments on the various drafts.

REFERENCES

Ajmal Ali, M., Gyulai, G., Hidvégi, N., Kerti, B., al Hemaid, F. M. A., Pandey, A. K., & Lee, J. (2014). The changing epitome of species identification - DNA barcoding. In Saudi Journal of Biological Sciences (Vol. 21, Issue 3, pp. 204–231). Elsevier. https://doi.org/10.1016/j.sjbs.2014.03.003

Austen, G. E., Bindemann, M., Griffiths, R. A., & Roberts, D. L. (2016). Species identification by experts and non-experts: Comparing images from field guides. Scientific Reports, 6. https://doi.org/10.1038/srep33634

Kallies, A. (2003). Three new species of Heterosphecia LE CERF, 1916, from the Oriental Region (Lepidoptera: Sesiidae, Sesiinae).

Bakker, F. T., Antonelli, A., Clarke, J. A., Cook, J. A., Edwards, S. v., Ericson, P. G. P., Faurby, S., Ferrand, N., Gelang, M., Gillespie, R. G., Irestedt, M., Lundin, K., Larsson, E., Matos-Maraví, P., Müller, J., von Proschwitz, T., Roderick, G. K., Schliep, A., Wahlberg, N., … Källersjö, M. (2020). The global museum: Natural history collections and the future of evolutionary science and public education. PeerJ, 8. https://doi.org/10.7717/peerj.8225

Boroff, D. (2015). Another Cecil? Researcher for New York museum kills rare bird in name of science, draws outrage from PETA. Daily News. https://www.nydailynews.com/new-york/researcher-ny-museum-kills-rare-bird-science-article-1.2394167. Accessed on 20th February 2023.

Callaghan CT, Mesaglio T, Ascher JS, Brooks TM, Cabras AA, Chandler M, et al. (2022) The benefits of contributing to the citizen science platform iNaturalist as an identifier. PLoS Biol 20(11): e3001843. https://doi.org/10.1371/journal.pbio.3001843

Estrada, A., Garber, P. A., Rylands, A. B., Roos, C., Fernandez-Duque, E., Fiore, A. di, Anne-Isola Nekaris, K., Nijman, V., Heymann, E. W., Lambert, J. E., Rovero, F., Barelli, C., Setchell, J. M., Gillespie, T. R., Mittermeier, R. A., Arregoitia, L. V., de Guinea, M., Gouveia, S., Dobrovolski, R., … Li, B. (2017). Impending extinction crisis of the world's primates: Why primates matter. In Science Advances (Vol. 3, Issue 1). American Association for the Advancement of Science. https://doi.org/10.1126/sciadv.1600946

Filardi, C. E. (2015). Why I Collected a Moustached Kingfisher. Audobon. https://www.audubon.org/news/why-i-collected-moustached-kingfisher. Accessed on 20th February 2023

Fraisl, D., Hager, G., Bedessem, B. et al. Citizen science in environmental and ecological sciences. Nat Rev Methods Primers 2, 64 (2022). https://doi.org/10.1038/s43586-022-00144-4

Funk, V. A., Edwards, R., & Keeley, S. (2018). The problem with(Out) vouchers. In Taxon (Vol. 67, Issue 1, pp. 3–5). International Association for Plant Taxonomy. https://doi.org/10.12705/671.1

GBIF (2022) a. iNaturalist contributors, iNaturalist (2023). iNaturalist Research-grade Observations. iNaturalist.org. Occurrence dataset https://doi.org/10.15468/ab3s5x [accessed via GBIF.org on 2023-02-20.]

GBIF (2022) b. Heterosphecia Le Cerf, 1917 in GBIF Secretariat (2021). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei [accessed via GBIF.org on 2022-11-12.]

Gorbunov, O. G., & Severtsov, A. N. (2015). Scientific Note: Clearwing moths (Lepidoptera: Sesiidae) of Laos. I. Akaisphecia melanopuncta O. Gorbunov & Arita, 1995 (Sesiidae: Sesiinae: Osminiini). In TROP. LEPID. RES (Vol. 25, Issue 2).

Hope, A. G., Sandercock, B. K., & Malaney, J. L. (2018). Collection of Scientific Specimens: Benefits for Biodiversity Sciences and Limited Impacts on Communities of Small Mammals. In BioScience (Vol. 68, Issue 1, pp. 35–42). Oxford University Press. https://doi.org/10.1093/biosci/bix141

iNaturalist. (2022). Oriental Blue Clearwing (Heterosphecia tawonoides). https://www.inaturalist.org/observations/107359556. Accessed 20th February 2023

iNaturalist. (2023). a. Frequently Asked Questions. https://www.inaturalist.org/pages/help#general1. Accessed on 20th February 2023

iNaturalist. (2023). b. Licensed to Share! https://www.inaturalist.org/posts/58298-licensed-to-share. Accessed on 20th February 2023.

iNaturalist. (2023). c. iNaturalist Computer Vision Explorations. https://www.inaturalist.org/pages/computer_vision_demo. Accessed 20th February 2023.

iNaturalist. (2023). d. Observations. https://www.inaturalist.torg/observations. Accessed 20th February 2023.

iNaturalist. (2023) e. FAQ: What is the data quality assessment and how do observations qualify to become "Research Grade"? https://www.inaturalist.org/pages/help. Accessed on 20th February 2023.

Kirillov, P., Pormansyah, P., Setiawan, D., Pragustiandi, G., Setiawan, A., & Yustian, I. (2022). Range extension of the endemic Sumatran admiral Vanessa samani (Hagen, 1895) (Lepidoptera: Nymphalidae) in Sumatra, Indonesia. Indonesian Journal of Applied Environmental Studies, 3(1), 30–33. https://doi.org/10.33751/injast.v3i1.4602

Koch, W., Hogeweg, L., Nilsen, E. B., & Finstad, A. G. (2022). Maximizing citizen scientists' contribution to automated species recognition. Scientific Reports, 12(1). https://doi.org/10.1038/s41598-022-11257-x

Koo, K. S., Oh, J. M., Park, S. J., & Im, J. Y. (2022). Accessing the Accuracy of Citizen Science Data Based on iNaturalist Data. Diversity, 14(5). https://doi.org/10.3390/d14050316

Krell, F. T., & Wheeler, Q. D. (2014). Specimen collection: Plan for the future. In Science (Vol. 344, Issue 6186, pp. 815–816). American Association for the Advancement of Science. https://doi.org/10.1126/science.344.6186.815

Kürzel, K., Kaiser, S., Lörz, A. N., Rossel, S., Paulus, E., Peters, J., Schwentner, M., Martinez Arbizu, P., Coleman, C. O., Svavarsson, J., & Brix, S. (2022). Correct Species Identification and Its Implications for Conservation Using Haploniscidae (Crustacea, Isopoda) in Icelandic Waters as a Proxy. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.795196

Marshall, S. A. (2018). Digital Photography and the Democratization of Biodiversity Information. http://carabidae.org/

Marshall, S. A., & Evenhuis, N. L. (2015). New species without dead bodies: A case for photobased descriptions, illustrated by a striking new species of Marleyimyia Hesse (Diptera, Bombyliidae) from South Africa. ZooKeys, 2015(525), 117–127. https://doi.org/10.3897/zookeys.525.6143

Minteer, B. A., Collins, J. P., Love, K. E., & Puschendorf, R. (2014). Avoiding (re)extinction. In Science (Vol. 344, Issue 6181, pp. 260–261). American Association for the Advancement of Science. https://doi.org/10.1126/science.1250953

Molyneaux, A., Hankinson, E., Kaban, M., Svensson, M. S., Cheyne, S. M., & Nijman, V. (2021). Primate Selfies and Anthropozoonotic Diseases: Lack of Rule Compliance and Poor Risk Perception Threatens Orangutans. Folia Primatologica, 92(5–6), 296–305. https://doi.org/10.1159/000520371

Molyneaux, A. (2022). Bukit Lawang and Beyond: Primates and Tourism from a Provider's Perspective. In: Gursky, S.L., Supriatna, J., Achorn, A. (eds) Ecotourism and Indonesia's Primates. Developments in Primatology: Progress and Prospects. Springer, Cham. https://doi.org/10.1007/978-3-031-14919-1_3

Mueller, M. A., Drake, D., & Allen, M. L. (2019). Using citizen science to inform urban canid management. Landscape and Urban Planning, 189, 362–371. https://doi.org/10.1016/j.landurbplan.2019.04.023

Naskreki, P (2014). Involuntary Bioslaughter and Why a Spider is Dead. The Smaller Majority. https://thesmallermajority.com/2014/10/08/the-sound-of-little-hooves-in-the-night/. Accessed 20th February 2023.

Perring TM, Cooper AD, Rodriguez RJ, Farrar CA, Bellows TS Jr. Identification of a whitefly species by genomic and behavioral studies. Science. 1993 Jan 1;259(5091):74-7. doi: 10.1126/science.8418497. PMID: 8418497.

Pühringer, F. (2022). Checklist of the Sesiidae of the world (Lepidoptera: Ditrysia). http://www.sesiidae.net/Checklst.htm. Accessed 20th February 2023.

Rocha LA, Aleixo A, Allen G, Almeda F, Baldwin CC, Barclay MV, Bates JM, Bauer AM, Benzoni F, Berns CM, Berumen ML, Blackburn DC, Blum S, Bolaños F, Bowie RC, Britz R, Brown RM, Cadena CD, Carpenter K, Ceríaco LM, Chakrabarty P, Chaves G, Choat JH, Clements KD, Collette BB, Collins A, Coyne J, Cracraft J, Daniel T, de Carvalho MR, de Queiroz K, Di Dario F, Drewes R, Dumbacher JP, Engilis A Jr, Erdmann MV, Eschmeyer W, Feldman CR, Fisher BL, Fjeldså J, Fritsch PW, Fuchs J, Getahun A, Gill A, Gomon M, Gosliner T, Graves GR, Griswold CE, Guralnick R, Hartel K, Helgen KM, Ho H, Iskandar DT, Iwamoto T, Jaafar Z, James HF, Johnson D, Kavanaugh D, Knowlton N, Lacey E, Larson HK, Last P, Leis JM, Lessios H, Liebherr J, Lowman M, Mahler DL, Mamonekene V, Matsuura K, Mayer GC, Mays H Jr, McCosker J, McDiarmid RW, McGuire J, Miller MJ, Mooi R, Mooi RD, Moritz C, Myers P, Nachman MW, Nussbaum RA, Foighil DÓ, Parenti LR, Parham JF, Paul E, Paulay G, Pérez-Emán J, Pérez-Matus A, Poe S, Pogonoski J, Rabosky DL, Randall JE, Reimer JD, Robertson DR, Rödel MO, Rodrigues MT, Roopnarine P, Rüber L, Ryan MJ, Sheldon F, Shinohara G, Short A, Simison WB, Smith-Vaniz WF, Springer VG, Stiassny M, Tello JG, Thompson CW, Trnski T, Tucker P, Valqui T, Vecchione M, Verheyen E, Wainwright PC, Wheeler TA, White WT, Will K, Williams JT, Williams G, Wilson EO, Winker K, Winterbottom R, Witt CC. Specimen collection: an essential tool. Science. 2014 May 23;344(6186):814-5. doi: 10.1126/science.344.6186.814. PMID: 24855245.

Ronque M.U.V., Azevedo-Silva M, Mori GM, Souza AP, Oliveira PS (2016). Three ways to distinguish species: using behavioural, ecological, and molecular data to tell apart two closely related ants, Camponotus renggeri and Camponotus rufipes (Hymenoptera: Formicidae), Zoological Journal of the Linnean Society, Volume 176, Issue 1, Pages 170–181, https://doi.org/10.1111/zoj.12303

Russo, D., Ancillotto, L., Hughes, A. C., Galimberti, A., & Mori, E. (2017). *Collection of voucher specimens for bat research: conservation, ethical implications, reduction, and alternatives. Mammal Review, 47(4), 237–246.* doi:10.1111/mam.12095

Silber, E. (2015). Moustached Kingfisher Photographed for First Time. Audobon. https://www.audubon.org/news/moustached-kingfisher-photographed-first-time. Accessed 20th February 2023.

Skowron Volponi, M. (2020). A vivid orange new genus and species of braconid-mimicking clearwing moth (Lepidoptera: Sesiidae) found puddling on plecoptera exuviae. *Insects, 11(7), 1–9*. https://doi.org/10.3390/insects11070425

Skowron Volponi, M. (2022). Hidden jewels of Malaysia: two new genera and species of remarkable clearwing moths (Lepidoptera: Sesiidae: Osminiini). *European Zoological Journal, 89(1), 579–589*. https://doi.org/10.1080/24750263.2022.2061613

Skowron Volponi, M. A., & Volponi, P. (2017). A 130-Year-Old Specimen Brought Back to Life: A Lost Species of Bee-Mimicking Clearwing Moth, Heterosphecia tawonoides (Lepidoptera: Sesiidae: Osminiini), Rediscovered in Peninsular Malaysia's Primary Rainforest. *Tropical Conservation Science, 10*. https://doi.org/10.1177/1940082917739774

Spiesman, B. J., Gratton, C., Hatfield, R. G., Hsu, W. H., Jepsen, S., McCornack, B., Patel, K., & Wang, G. (2021). Assessing the potential for deep learning and computer vision to identify bumble bee species from images. *Scientific Reports, 11(1)*. https://doi.org/10.1038/s41598-021-87210-1

Suarez, A., & Tsutsui, N. D. (2004). The Value of Museum Collections for Research and Society Orchid-Orchid Bee Systematics View project. https://www.researchgate.net/publication/261795120

Sun, C. C., Hurst, J. E., & Fuller, A. K. (2021). Citizen Science Data Collection for Integrated Wildlife Population Analyses. Frontiers in Ecology and Evolution, 9. https://doi.org/10.3389/fevo.2021.682124

Turney, S., Cameron, E. R., Cloutier, C. A., & Buddle, C. M. (2015). Non-repeatable science: Assessing the frequency of voucher specimen deposition reveals that most arthropod research cannot be verified. PeerJ, 2015(8). https://doi.org/10.7717/peerj.1168

Valan, M., Makonyi, K., Maki, A., Vondráček, D., & Ronquist, F. (2019). Automated Taxonomic Identification of Insects with Expert-Level Accuracy Using Effective Feature Transfer from Convolutional Networks. *Systematic Biology, 68(6), 876–895*. https://doi.org/10.1093/sysbio/syz014

Waeber, P. O., Gardner, C. J., Lourenco, W. R., & Wilme, L. (2017). On specimen killing in the era of conservation crisis - A quantitative case for modernizing taxonomy and biodiversity inventories. *PLoS ONE, 12(9)*. https://doi.org/10.1371/journal.pone.0183903

Walpole, M. J., & Leader-Williams, N. (2002). Tourism and flagship species in conservation. In Biodiversity and Conservation (Vol. 11).

Wilson, J. S., Pan, A. D., General, D. E. M., & Koch, J. B. (2020). More eyes on the prize: an observation of a very rare, threatened species of Philippine Bumble bee, Bombus irisanensis, on iNaturalist and the importance of citizen science in conservation biology. Journal of Insect Conservation, 24(4), 727–729. https://doi.org/10.1007/s10841-020-00233-3

InJAST
Volume 4, Number 1, April 2023
Pages: 46-54

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: 10.33751/injast.v4i1.3107

Daily behaviour and home range of adult rehabilitant Javan slow loris (*Nycticebus javanicus* É. Geoffroy, 1812) in Gunung Sawal Nature Reserve, Ciamis, West Java

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Submitted 7 March 2021; Accepted 1 April 2023

ABSTRACT

This study aims to determine the differences in daily behaviour and home range of male and female rehabilitated Javan slow loris (*Nycticebus javanicus*) in Gunung Sawal Nature Reserve, Ciamis, West Java, Indonesia. The study was conducted on four individuals of Javan slow loris rehabilitates (two adult males and two adult females) during their post-released monitoring period. Those animals were fitted with a radio transmitter and were monitored for their daily behaviour and home range for six months (May - October 2018). The focal animal sampling method was employed for daily behaviour observation. The home range of each individual was estimated by Minimum Convex Polygon (MCP) and Kernel Density Estimation (KDE) methods. Data analysis was descriptively displayed in maps, tables, and figures. According to the statistical analyses of the Mann Whitney U test, there are no significant differences (μ = 1,074,554.5 [$p < 0.01$]; P-Value 0.238 > 0.01) in the daily behaviour of male and female Javan slow loris rehabilitate. In contrast, the home range (vertically and horizontally) of female and male Javan slow loris rehabilitate are significantly different (μ = 816,286.0 [$p < 0.01$]; P-Value 0.000 < 0.01).

ABSTRAK

Penelitian ini bertujuan untuk mengetahui perbedaan perilaku harian dan wilayah jelajah kukang jawa (*Nycticebus javanicus*) jantan dan betina hasil rehabilitasi di Suaka Margasatwa Gunung Sawal, Ciamis, Jawa Barat, Indonesia. Penelitian dilakukan pada empat individu kukang jawa rehabilitan (dua jantan dewasa dan dua betina dewasa) selama masa pemantauan pasca pelepasliaran. Satwa-satwa tersebut dipasangi pemancar radio serta dipantau perilaku harian dan wilayah jelajahnya selama enam bulan (Mei - Oktober 2018). Metode pengambilan sampel "Focal Animal" digunakan untuk pengamatan perilaku harian. Daerah jelajah masing-masing individu diperkirakan dengan metode Minimum Convex Polygon (MCP) dan Kernel Density Estimation (KDE). Analisis data secara deskriptif ditampilkan dalam bentuk peta, tabel, dan gambar. Berdasarkan analisis statistik uji U-Mann Whitney, tidak terdapat perbedaan yang bermakna (μ = 1.074.554,5 [$p < 0,01$]; P-Value 0,238 > 0,01) pada perilaku harian kukang jawa jantan dan betina yang direhabilitasi. Sebaliknya, wilayah jelajah (vertikal dan horizontal) kukang jawa betina dan jantan yang direhabilitasi berbeda nyata (μ = 816.286,0 [$p < 0,01$]; P-Value 0,000 < 0,01).

Keywords: *daily behaviour, home range, Javan slow loris, rehabilitant, Gunung Sawal Nature Reserve*

INTRODUCTION

Indonesia boasts a remarkable diversity of primate species, with 60 out of approximately 250 known species worldwide. For this reason, Indonesia places globally among the countries with the highest primate species richness (Supriatna & Ramadhan, 2016; Supriatna, 2019). Notably, at least 36 of these primate species, comprising 60% of the total, are endemic to Indonesia (Supriatna & Ramadhan, 2016). Indonesia possesses a primate species known as the Javan slow loris (*Nycticebus javanicus* É. Geoffroy, 1812), which is exclusive to Java

Island (Groves, 2001; Nekaris & Jaffe, 2007; Maryanto et al., 2008; Supriatna, 2019).

According to Lehtinen (2013), slow lorises are exclusively distributed in South and Southeast Asia. Presently, there are eight recognized species of slow lorises, namely the Bengal slow loris (*Nycticebus bengalensis*), Dwarf slow loris (*N. pygmaeus*), Sunda slow loris (*N. coucang*) also occurs in Baturegi Protected Forest in Lampung (Huda et al, 2020), Philippine slow loris (*N. menagensis*), Javan slow loris (*N. javanicus*), Sodhi slow loris (*N. bancanus*), Bornean slow loris (*N. borneanus*), and Kayan slow loris (*N. kayan*). Slow lorises are distributed across the Indonesian islands of Sumatra, Kalimantan, and Java. The slow lorises inhabit the islands' tropical forests and prefer primary forests, secondary forests, shrubs, and bamboo groves. According to Nekaris and Starr (2015), slow lorises play a significant ecological role in tropical forests as one of the arboreal fauna.

According to the IUCN Red List, the Javan slow loris was classified as endangered (EN) in 2010 and reclassified as critical (CR) in 2013. In Indonesia, the Javan slow loris is a protected wild animal under Law No. 5 of 1990 and Government Regulation No. 7 of 1999 (Supriatna & Wahyono, 2000). The decline in slow loris populations in their natural habitat is attributed to the loss of their habitat and the illicit trade of these animals, as the IAR Indonesia Foundation reported in 2011. Illegal wildlife trade now can be found either through offline or online transactions (Priatna & Monk, 2022).

According to Sjahfirdi et al. (2009), daily behaviour is a purposeful action influenced by an individual's surroundings and available resources. Tanudimadja (1978) defines wild animal behaviour as the manifestation of animal expression influenced by environmental factors, including the availability of food and water sources, the presence of predators, the necessity to reproduce, and human interference. The primary purpose of behavioural adaptation is to adjust to various environmental alterations from internal and external sources.

Slow lorises are solitary primates (Wiens, 2002; Wiens & Zitzmann, 2003; Napier & Napier, 1985; Rowe, 1996). Solitary behaviour in slow lorises is generally accepted; there is no significant difference between sexes or age classes between adults or immature individuals (Wiens, 2002).

Santosa (1990) states that the parameters of spatial use patterns most studied are home ranges and movements. The use of space in habitat is crucial to comprehending the use of forest strata and various types of substrates by animals in carrying out their activities. (Hasan et al., 2007). In searching for food sources, primates use space based on height (vertical stratum) and substrate (horizontal stratum) (Hassan & Kitegile, 2022).

Information obtained from the daily behaviour and movement of animals will provide an overview of the ecology of the species. Information on spatial use patterns is also important concerning how a wildlife species interacts with its environment. This research on the daily behaviour and range of the rehabilitated Javan slow loris in the Gunung Sawal Nature Reserve area is to answer the questions: (1) Are there differences in the daily behaviour of adult male Javan slow loris and rehabilitated adult females in nature? Moreover, (2) Are there differences in the ranges of male Javan slow lorises and rehabilitated females in nature? The information generated from this research can be used to develop and improve future Javan slow loris conservation efforts.

RESEARCH METHODOLOGY

Location and Time

This research was conducted in the Awilega Block, Gunung Sawal Nature Reserve, administratively located in Tanjungsari Village, Sadananya District, Ciamis Regency, West Java. (Figure 1). Field data was collected for six months, from May to October 2018.

Figure 1. Map of research site in Gunung Sawal Nature Reserve, Ciamis Regency, West Java, Indonesia.

Research Object

Four Javan slow loris, comprising two adult males and two adult females, served as the research subjects. The four animals were either confiscated slow lorises or had been kept as pets by the community, and they had undergone rehabilitation at the Slow Loris Rehabilitation Center of the IAR Indonesia Foundation. The four rehabilitated animals were returned to Gunung Sawal Wildlife Nature Reserve by the Natural Resources Conservation Agency of West Java in mid-2017 (about one year before this research was conducted).

Research Equipment

The study used Biotrack radio transmitters affixed to the four rehabilitated slow lorises as a means of monitoring. In addition, a CSI receiver and a Biotract yagi antenna are used to aid in locating the position of the slow loris, which has been fitted with a radio transmitter. Additional supporting tools used in this study include GPS map 67 CSX brand Garmin, digital cameras, flashlights, and stationery. Meanwhile, computer equipment and ArcGIS 10.1 software are used to process monitoring data.

How Radio Telemetry Works

Data collection on daily activities began with exploring the forest, where the four individuals were released to the wild with a radio transmitter attached to them. A receiver connected to the Yagi antenna is used to find the position of the slow loris. The radio transmitter attached to the slow loris will send a signal that the receiver can receive. When the yagi antenna is directed at one place and gives the strongest signal, that direction indicates the location of the slow loris (Andrusiak et al., 1998). This technique is commonly used in assisting research on the behaviour of prosimian primates active at night (nocturnal), such as Tarsier and Galago.

Work Procedures

Recording of daily behaviour

The daily behaviour of slow lorises was collected using the focal time sampling method (Martin & Bateson, 1993), which involved tracking the rehabilitated slow lorises from 6 p.m (Western Indonesian Time) to 06.00 a.m (Western Indonesian Time) the next day (about 12 hours). Slow lorises' daily nocturnal behaviour is divided into five categories: inactivity (resting/sleeping), travel, foraging, feeding, and hygiene (Nekaris, 2001). The data is recorded at five-minute intervals. Daily behaviour data were then arranged in a modified Fitch-Snyder & Schulze ethogram (Bottcher-Law et al., 2001) and (Glassman & Wells, 1984).

Animal roaming data collection techniques

Data for slow lorises were collected from 18:00 Indonesian Western Time to 06:00 Indonesian Western Time of the following day. Retrieval of location coordinate points begins when the slow loris becomes accustomed to the observer's presence, typically occurring approximately 5-10 minutes after the slow loris was spotted (Pambudi, 2008). The coordinates of the slow loris location are recorded every 15 minutes using GPS.

Data analysis

Daily behaviour data of four individuals of slow lorises were taken qualitatively and subsequently presented in various visual formats, including maps, tables, and pictures or graphs.

The division of vertical space use or forest tree canopy strata refers to the strata used in Pambudi's research (2008), namely forest floor strata (0-5 meters high), lower canopy strata (>5-10 meters high), middle canopy strata (height >10-15 meters), and upper canopy strata (height >15 meters), as measured from the forest floor.

The Javan slow loris home range is determined based on location coordinate point data collected in the field facilitated by the use of GPS technology. These data points are subsequently plotted onto a digital map for analysis and interpretation. The assessment of home range measurement and the evaluation of Javan slow loris habitat types were conducted using ArcGIS 10.1 software. The home range area is calculated using the Minimum Convex Polygon (MCP) and Kernel Density Estimation (KDE) methods.

Statistical test

Mann Whitney U Test was conducted to determine whether there are differences in daily behaviour and the home range size between adult male Javan slow lorises and rehabilitated females in the wild.

RESULTS AND DISCUSSION

Daily Behaviour

Daily activity

Over approximately six months, data were collected on the behaviour of four Javan slow lorises, consisting of two adult males and two adult females. A total of 3,075 male slow loris behaviour were recorded, with an average of 1,537.5 observations per individual. Similarly, 2,871 female slow loris behaviour was documented, with an average of 1,436.5 observations per individual. The results showed that adult male Javan slow lorises allocate a majority of their time (92.4%) to engaging in various activities and only use 7.6% of their time to rest/sleep. The largest proportion of active time is used for traveling (29.6%), feeding (25%), foraging (24.5%), and grooming (13.3%). In the case of adult female Javanese slow lorises, 12.1% of their time is allocated for resting/sleeping, while the remaining 87.9% is for various activities. The highest proportion of active time in female Javan slow lorises is spent traveling (26.9%), foraging (23%), feeding (19.6%), and grooming (18.4%) (Figure 2).

Daily activities based on time distribution

Observations indicate that rehabilitated Javan slow lorises (adult males and adult females) in the Gunung

Sawal Nature Reserve commence daily activity between 18:00 and 19:00 WIB. Most daily activity is allocated to travel, grazing, and foraging, with the most active period occurring between 20:00 and 24:00 Indonesian Western Time. Subsequently, the activity level of these slow lorises tends to decrease between 00:00 WIB and 03:00. Further, there was a subsequent increase in the level of activity exhibited by the slow lorises during 03.00-05.00.

The rehabilitant male Javan slow loris in the study area of Gunung Sawal typically initiates its activities at 18:00, with the peak of its activity observed between 21:00 and 24:00, accounting for 64.2% of its overall activity. In contrast, female rehabilitant slow lorises typically commence their daily routines between 18:00 to 21:00. The initial behaviour observed during this period is waking up and engaging in grooming activities. Adult female slow lorises are most active from 21:00 to 24:00, accounting for 61.1% of their total activity. Subsequently, their activity diminishes during the 00.00-03.00 WIB time frame, constituting only 6.8% of their overall activity. Nevertheless, their activity increased again from 3:00 to 6:00 WIB, up to 15.5% of their total activity, as presented in Figure 3.

The results showed that rehabilitant male slow lorises were more active than adult females by 92.4% versus 87.9%. Rode-Margono et al. (2014) report that female Javan slow lorises spend more time foraging, whereas males spend more time traveling. Meanwhile, Nekaris et al. (2017) contend that adult males spend more time traveling than adult females. The high time spent traveling in males is closely related to the behaviour of marking their territory using urine, as well as the distance between sleeping trees and foraging locations. This is congruent with the results shown by male and female rehabilitatant lorises observed, where the percentage of time adult males spend traveling was 29.6%, higher than that of adult females for traveling, only 26.9%. The high proportion of time spent traveling, feeding, and foraging by rehabilitant slow lorises (adult males and adult females) is because rehabilitant slow lorises generally take a long time to recognize their new habitat by exploring and simultaneously looking for suitable habitat to meet their food needs (foraging) to survive in the wild (IAR Indonesia Foundation, 2011).

Pambudi (2008) asserts that the Javan slow loris in the Bodogol, Gunung Gede Pangrango National Park forest area spends 65% of its time engaging in activities (14% traveling, 28% foraging, 13% feeding, and 10% grooming) and 35% resting/sleeping (inactive). Angeliza (2014), who studied two individuals of Javan slow loris on Gunung Halimun Salak National Park, discovered that individual A exhibited three prevalent loris behaviours: traveling (41.6% of the time), foraging (14.3% of the time) and feeding (14.1% of the time). Individual B, meanwhile, engaged in travel (34,1%), grazing (29,5%), and foraging (14,6%). This result is consistent with what

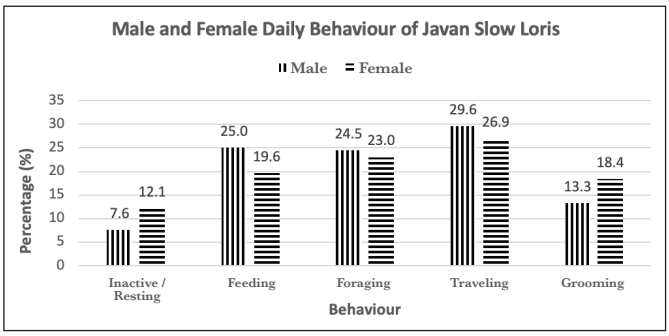

Figure 2. Percentage of the daily behaviour of male and female rehabilitant Javan slow lorises.

was observed by rehabilitant slow lorises in Gunung Sawal Nature Reserve, where traveling, grazing, and foraging are the primary daily activities.

Observation of the daily activities of the rehabilitant Javanese slow loris commences at 18:00 WIB and concludes at 06:00 the following day. The first behaviour observed between 18.00 and 19.00 is resting when the slow loris has just awoken and sits quietly observing its surroundings and grooming. According to (Nekaris, 2001), the slender loris begins its activities between 18.00 and 19.00 and concludes them between 05.00 and 06.00. Male slow lorises exhibit the greatest daily activity between 20:00 and 24:00. Activity tends to diminish and stabilize at 00.00 WIB until 06.00. In females' slow lorises, the highest daily activity occurs at 21.00-24.00. Activity decreases at 00.00-03.00 and will increase again at 03.00-06.00. Male and female slow lorises exhibit the same behaviour during their highest (dominant) daily activities, namely traveling, grazing, and foraging.

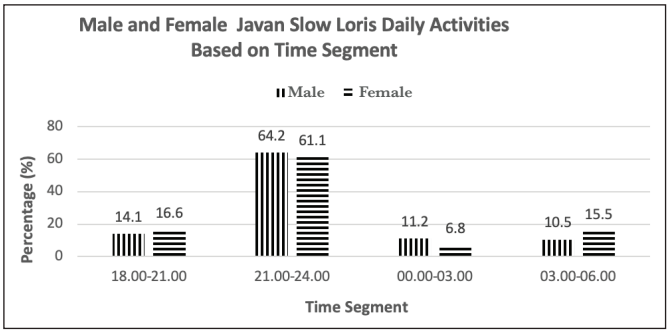

Figure 3. Daily activities based on time segment of male and female rehabilitant Javan slow lorises.

Slow lorises are nocturnal primates that are active after sunset. Slow lorises are very active, from 21.00 WIB to 00.00 WIB in nature. As the sun begins to rise, there will be a significant decrease in activity. The peak feeding activity of Java slow lorises occurs at 20:00 - 21:00 and 01:00 - 02:00 (Nekaris, 2001), while Pambudi (2008) stated that slow loris activity would begin to increase immediately after waking up and then decreases towards midnight and will increase again in the early morning to look for sleeping trees to rest.

Each slow loris' behaviour is substantially influenced by habitat conditions, individual animals, and the presence of predators and competing species.

Roaming

Primates utilize their habitat vertically as well as horizontally (Jolly, 1985). Habitat utilization horizontally and vertically can be investigated by mapping the home range to determine how much forest is utilized and which part of the forest is most often used by primates (Chalmers, 1980).

Vertical roaming

The pattern of vertical space utilization by slow lorises is influenced by the vegetation type and their foraging activity patterns. Foraging activities that impact strata use consist of searching for insects in tree trunks and searching for sap.

Based on our observational data (n = 3,075), male Javan slow lorises utilized vertical space most frequently at heights of 0-5 meters (58%), followed by heights of >5-10 meters (33.8%), >10-15 meters (7.2%), and only one percent (1%) above a height of >15 meters above the ground or forest floor. Meanwhile for female Javan slow lorises (n = 2,871 behaviours) used vertical space most frequently at heights > 5-10 meters (48.2%), > 5-10 meters (34.1%), > 10-15 meters (15.4%), and >15 meters above ground level or forest floor (2.3%). (See Figure 4).

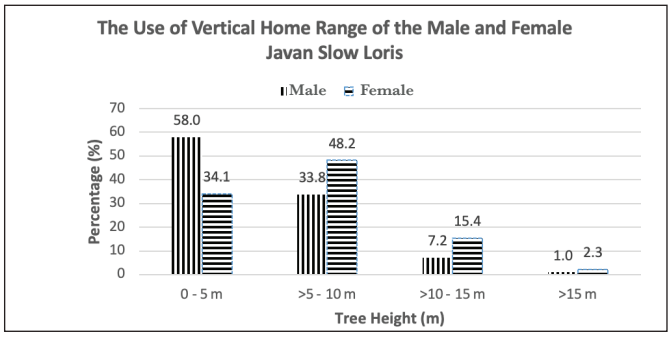

Figure 4. Percentage of use of vertical home range of male and female Javan slow lorises.

Horizontal roaming

The home range of the Javan slow loris was estimated using the Minimum Convex Polygon (MCP) and Kernel Density Estimation (KDE) methods. The KDE approach is used to display and estimate the core area (core range) and total area (fixed home range) used by slow lorises during observations.

During the observation of four Javan slow lorises, a total of 2,398 coordinate points were obtained for the tracking movement location (1,058 male coordinates and 1,340 female coordinates). Using the MCP (Minimum Convex Polygon) method, it is known that the male Javan slow loris has a home range of 46.9 ha, while the female has a home range of 42.7 ha (Figure 5). Meanwhile, using the KDE method, it was discovered that the male slow loris had a fixed home range of 25.4 hectares and a core range of 4.9 hectares, while the female slow loris had a fixed home range of 20.4 hectares and a core range of 4.4 hectares (Figure 6).

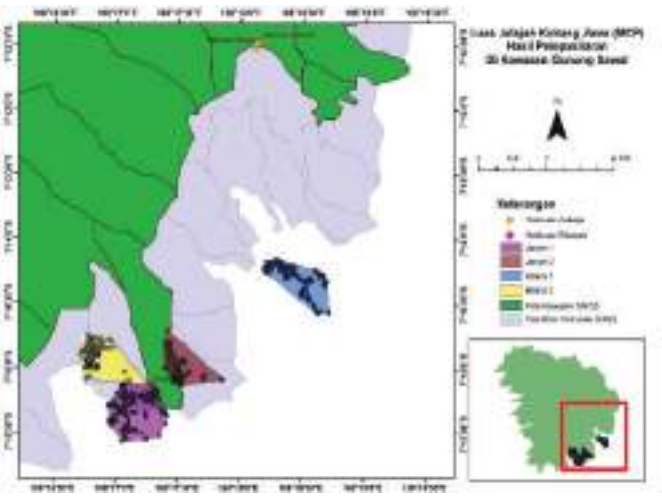

Figure 5. Home range of rehabilitant Javan slow lorises in the Gunung Sawal Nature Reserve area using the MCP (Minimum Convex Polygon) approach.

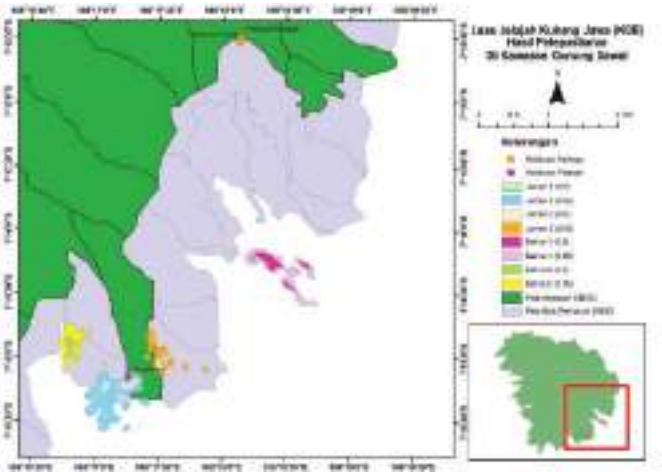

Figure 6. Home range of rehabilitant Javan slow lorises in the Gunung Sawal Nature Reserve area using the KDE (Kernel Density Estimation) approach.

habitat preference

Rehabilitant slow lorises released to the wild were observed using areas belonging to three status areas: the Gunung Sawal Nature Reserve area, the Perhutani area, and community-owned plantations.

Based on field monitoring which was then processed using a GIS (Geographical Information System), of 2,398 coordinated position points for four observed Javan slow lorises, the majority of slow lorises utilized secondary forest habitat and talun forest (forest managed by indigenous peoples in West Java). The analysis revealed that slow lorises spend 47.3% of their time in

the Perhutani area, 45.1% in community-owned plantations, and just 7.6% in the Gunung Sawal Nature Reserve area (Figure 7). Priatna et al. (2012a) suggested that the existence of natural forests within the landscape as habitat or cover remains important for the survival of wildlife, particularly terrestrial mammals.

Moreover, observations result indicate that the rehabilitant Javan slow loris range is 500 to 800 meters above sea level. Most activities occur between 600 and

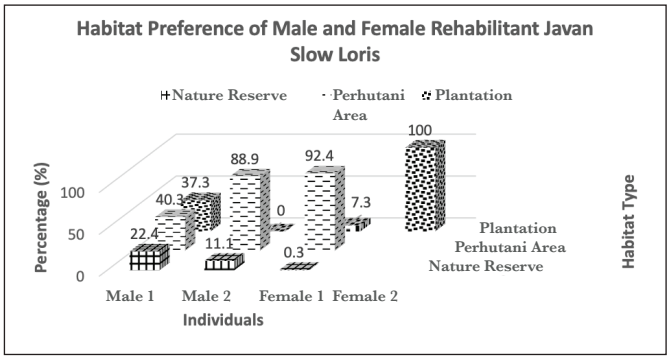

Figure 7. Habitat preferences of the relabilitant Javan slow loris in the Gunung Sawal Nature Reserve area.

800 meters above sea level, predominantly in Perhutani areas and plantations owned by the community.

Slow lorises are slow-moving animals that ascend using all four legs (quadrupedal). Slow lorises are capable of bridging (forming like a bridge) between tree branches at various angles, as they cannot jump (Wiens & Zitzmann, 2003).

Based on empirical evidence, male Javan slow lorises predominantly engage in vertical cruising within a range of 0-5 meters above ground level, accounting for approximately 58% of their activity. Subsequently, vertical cruising occurs at higher heights, with 33.8% occurring at a height of > 5-10 meters, 7.2% at > 10-15 meters, and a mere 1% occurring at a height > 15 meters above ground level. In the case of female slow lorises, vertical cruising predominantly occurred at a height of > 5-10 meters from the ground, accounting for 48.2% of observations. Subsequently, cruising was observed at > 5-10 meters (34.1%), >10-15 meters (15.4%), and a mere 2.3% of instances involved cruising at> 15 meters above the ground. A notable disparity exists in the vertical utilization patterns of male and female slow lorises, particularly concerning the predominant height ranges employed for various activities. Specifically, male slow lorises are more inclined to utilize heights within the 0-5 meter range, accounting for 58% of their overall activity. Conversely, female slow lorises demonstrate a higher level of engagement at heights> 5-10 meters, constituting 48.2% of their total activity.

The data collected from observations indicated that a significant majority, exceeding 70%, of both male and female slow lorises engaged in activities primarily within the arboreal habitat. These activities were predominantly observed at two specific height ranges, 0-5 meters and > 5-10 meters above ground level. Generally, male and female slow lorises typically utilize vertical spatial areas within the lower to medium height range, specifically between 0 and 10 meters above ground level. The statement exhibits a strong correlation between This is closely related to the condition of the vegetation in the slow loris' home range. According to Arismayanti's (2014) findings, the Javan slow loris inhabiting Gunung Halimun Salak National Park engages in foraging activities within a lower canopy at a height ranging from 2 to 8 meters above ground level. The Javan slow loris in Bodogol Gunung Gede Pangrango National Park and the Tasikmalaya and Ciamis taluns (Pambudi, 2008; Winarti, 2011) exhibits similar behaviour by utilizing a height range of 3-12 meters above the ground for feeding and foraging (Putri, 2014; Winarti, 2011). In the context of the observed rehabilitant of slow lorises, the daily behaviours exhibited by the subjects included periods of inactivity (resting/sleeping), feeding, foraging, moving, and grooming. These activities were predominantly conducted within a height range of 0-10 meters from the ground, accounting for over 70% of the observed behaviours. The utilization of these strata is intricately linked to the specific vegetation type and foraging behaviour of slow lorises. Foraging behaviours that impact the utilization of different strata encompass activities such as searching for insects within tree trunks or seeking sap.

The data obtained from the study of the Javan slow loris includes 2,398 coordinate points representing their movement patterns. This dataset comprises 1,058 coordinates for males and 1,340 coordinates for females. According to the Minimum Convex Polygon (MCP) method, the male Javan slow loris exhibits a home range stretching 46.9 hectares. In comparison, the female Javan slow loris demonstrates a home range encompassing 42.7 hectares. The findings derived from applying the Kernel Density Estimation (KDE) method indicates that male slow lorises exhibit a consistent home-range size of 25.4 hectares, while female slow lorises possess a home-range size of 20.4 hectares. In the study by Moore et al. (2014), the rehabilitant slow loris by the International Animal Rescue Indonesia Foundation (YIARI) exhibited a home range spanning 29.21 hectares. The Javan slow loris, following its rehabilitation and subsequent reintroduction into its native environment, engages in exploratory behaviour to identify and establish its territory within regions other loris individuals have not occupied. The slender loris, belonging to the genus Loris, is the research subject in Sri Lanka and India. It is a small primate weighing between 0.1-2.5 kg. Studies have indicated that the loris has a home range extending up to 35 hectares (Nekaris & Bearder, 2011; Wiens &

Zitzmann, 2003; Wiens et al., 2006). The home range refers to the spatial extent within which an animal resides and actively defends against intrusions by conspecifics. According to Alikodra (2002), when a particular species starts to protect its area of residence from intruders of the same species, it establishes a territory.

Based on the results of calculating the home range using the KDE method, the home range area for the rehabilitant slow loris studied demonstrates a narrower home range (Moore et al., 2014; Nekaris & Bearder, 2011; Wiens & Zitzmann, 2003; Wiens et al., 2006). The shrinkage range is because the data for the range points are collected three months after the slow lorises have reached a stable adaptation period.

Using the Kernel Density Estimation (KDE) method, the male slow loris' core–range area is 4,9 ha, while the female's is 4,4 ha. After a sustained adaptation period, the four released individuals, consisting of two males and two females, established a core and home range similar to the wild Javan slow loris. The core-range area is considered territorial significance for each individual, ensuring their protection against predators, competitors, and human interference. According to Wiens (2002), the home range of slow lorises varies depending on their habitat type. In primary forest, the home range of slow lorises is between 0.4 and 3.8 hectares; in forests affected by logging disturbances, it expands to 2.8-8.9 hectares; and in grasslands savanna, it is between 10.4 and 25 hectares. According to Arismayanti (2014), the home ranges of two Javan slow loris individuals on Gunung Halimun Salak National Park are 5.44 ha and 5.50 ha, respectively. According to the data presented, there is no significant difference between the home ranges of rehabilitant and wild Javan slow lorises. According to Priatna et al. (2012b) the home range and movement of animals are affected by their surroundings and the distribution of the resources they need to grow, reproduce and survive.

The rehabilitan Javan slow loris typically inhabits elevations ranging from 500 to 800 meters above sea level (asl). Notably, these slow lorises exhibit their highest frequency of activity within the altitude range of 600 to 800 meters asl. Based on field monitoring and GIS (geographic information system) analysis, most slow lorises inhabit secondary forest and talun garden habitats. Based on field observations, the majority of these areas are in the Perhutani area and plantations belonging to the community, which contain forage plants utilized by the Javan slow loris for rehabilitation in the Gunung Sawal Nature Reserve area, such as Kaliandra, Mahogany, Sengon, Aren, and Bamboo. In addition, there exist various species of indigenous forest flora, including Puspa, Tepus, Bungbuay, and Bingbin. Food sources for the rehabilitated Javan slow loris in the Gunung Sawal Nature Reserve consist primarily of nectar from flowering plant species, sap from stems, and branches of wood that the slow lorises peel off. In addition, slow lorises consume numerous species of insects and reptiles. The Javan slow loris has been observed consuming the sap extracted from palm trees that palm sugar farmers are tapping. From the perspective of indigenous knowledge, the local community implies that the palm flower clusters visited by the Javan slow loris tend to release high-quality water. Furthermore, in its natural habitat, the Javan slow loris commonly relies on palm sap, locally referred to as bubudur, as a natural food resource.

Based on the statistical analysis of the Mann Whitney U test, there was no significant difference (μ = 1,074,554.5 [$p < 0.01$]; P-Value 0.238 > 0.01) between the daily behaviour of male and female Javan slow lorises that were rehabilitated and released in the Gunung Sawal Nature Reserve Area. Meanwhile, the home ranges (vertical and horizontal) of female and male Javan slow lorises rehabilitated and released in Gunung Sawal Nature Reserve were significantly different (μ = 816,286.0 [$p < 0.01$]; P-Value 0.000 < 0.01).

CONCLUSION

There was no statistically significant difference in daily behaviour between male and female Javan slow lorises undergoing rehabilitation in the Gunung Sawal region, as determined by the Mann-Whitney U Test. Theoretically, there should be differences in their daily behaviours. It is conceivable that there are no differences in daily behaviour because the research samples are small, and the field data collection period is brief.

Based on statistical tests using the Mann-Whitney U Test, there were differences in vertical and horizontal ranges between male and female rehabilitant Javan slow lorises in the Gunung Sawal area. Male Javan slow lorises traversed mostly at canopy height/strata of 0-5 meters (58%), and female Javan slow lorises mainly were at altitudes >5-10 meters (48.2%). The horizontal range on the male Javan slow loris was 46.9 ha, and the female Javan slow loris was 42.7 ha using the Minimum Convex Polygon (MCP) approach. In contrast, using the Kernel Density Estimation (KDE) method, the male Javan slow loris was 25.4 ha, and the female Java slow loris was 20 .4 ha for fixed home range and 4.9 ha male Javan slow loris and 4.4 ha female Javan slow loris for core-range.

REFERENCES

Andrusiak, L., Walters, E., Terry, E., and Simpson, K. 1998. *Wildlife Radio Telemetry: Standards for Components of British Columbia's Biodiversity No. 5*. Vancouver (BC): Ministry of Environment, Lands and Parks.

Angeliza, R. 2014. Aktivitas Harian Kukang Jawa (*Nycticebus javanicus*) di Taman Nasional Gunung Halimun Salak, Jawa Barat. [Skripsi]. Bogor (ID): Institut Pertanian Bogor.

Alikodra, H.S. 2002. *Pengelolaan Satwaliar*. Bogor (ID): Yayasan Penerbit Fakultas Kehutanan IPB.

Arismayanti E. 2014. Daerah Jelajah dan Penggunaan Ruang Kukang Jawa (*Nycticebus javanicus*) di Taman Nasional Gunung Halimun Salak, Jawa Barat. [Skripsi]. Bogor (ID): Institut Pertanian Bogor.

Bottcher-Law L., Fitch H., and Schulze, S H. 2001. Management of lorises in captivity: a husbandry manual of Asian lorisines (Nycticebus & Loris spp.) San Diego (US): Cres, Zool Soc San Diego.

Chalmers, N. 1980. *Social Behavior in Primates*. Baltimore: University Park Press.

Glassman, D.M. and Wells, J.P. 1984. Positional and activity behavior in a captive slow loris: A quantitative assessment. *American Journal of Primatology (7): 121-132*.

Groves, C. 2001. *Primate Taxonomy*. Washington DC(US): Smithsonian Institution Press.

Hasan, M., Feeroz, M., Islam, M., Kabir, M. and Begum, S. 2007. Substrate use by the western hoolock gibbon (Hoolock hoolock) in a semievergreen forest of Bangladesh. *Zoo's Print Journal 22 (6): 2701-2705*.

Huda, R., Istiadi, Y. and Priatna, D. 2020. Differences of terrestrial mammal species diversity between natural forest and edge forest areas in Batutegi Protected Forest, Lampung, Indonesia. *Indonesian Journal of Applied Environmental Studies 1(1): 33-39*.

[IUCN] International Union for Conservation of Nature. 2013. IUCN Red List of Threatened Species, Nyticebus (*Nycticebus javanicus*) [Internet]. [10 Oct 2019]. http://www.iucnredlist.org

Jolly, A. 1985. *The Evolution of Primate Behavior*. 2nd ed. New York: Macmillan Publishing Company.

Martin, P. and Bateson, P. 1993. *Measuring Behaviour*. Volume 2. London (GB): Cambridge University Press.

Maryanto, I., Acmadi, A.S. and Kartono, A.P. 2008. *Mamalia Dilindungi Perundang-undangan Indonesia*. Bogor: Lembaga Ilmu Pengetahuan Indonesia.

Moore, S.R., Huda, R. and Sanchez, K.L. 2014. Home range size and use in translocated *Nycticebus javanicus* in Halimun Salak National Park, West Java. In: International Primatology Society Conference XXV; Hanoi, Vietnam. Vietnam (VN): International Primatology Society. 375.

Napier, J. R., and P. H. Napier. 1985. *The Natural History of the Primates*. Cambridge: The M.I.T. Press.

Nekaris, K.A.I. 2001. Activity budget and positional behavior of the Mysore slender loris: Implications for slow climbing locomotion. *Folia Primatologica 72: 228-241*.

Nekaris, K.A.I. and Jaffe, S. 2007. Unexpected diversity of slow lorises (Nycticebus spp.) within the Javan pet trade: impications for slow loris taxonomy. *Contributions to Zoology 76: 187-196*.

Nekaris, K.A.I. and Bearder, S.K. 2011. *The Lorisiform Primates of Asia and Mainland Africa: Diversity Shrouded in Darkness*. In: Primates in Perspective (Eds: C. J. Campbell, A. Fuentes, K. C. MacKinnon, S. K. Bearder and R. M. Stumpf). Oxford (GB): Oxford University Press.

Nekaris, K.A.I., Poindexter S, Reinhardt, K.D., Sigaud, M., Cabana, F., Wirdateti, W. and Nijman, V. 2017. Coexistence between Javan Slow Lorises (*Nycticebus javanicus*) and humans in a dynamic agroforestry landscape in West Java, Indonesia. *International Journal of Primatology 38: 303-320*.

Pambudi, I.A.A. 2008. Studi Perilaku dan Ekologi Kukang jawa di Kawasan Hutan Bedogol, Taman Nasional Gunung Gede Pangrango [Thesis].Depok: Universitas Indonesia

Priatna, D. and Monk, K.A. 2022. The role of the academic community in combating wildlife trafficking. *Indonesia Journal of Applied Environmental Studies 3(2): 85-91*. Doi: 10.33751/injast.v3i2.6302

Priatna, D., Santosa, Y., Prasetyo, L.B. and Kartono, A.P. 2012a. Habitat selection and activity pattern of GPS collared Sumateran tigers. *Jurnal Manajemen Hutan Tropika XVIII(3): 155-163*.

Priatna, D., Santosa, Y., Prasetyo, L.B. and Kartono, A.P. 2012b. Home range and movements of male translocated problem tigers in Sumatra. *Asian Journal of Conservation Biology 1(1): 20-30*.

Putri, R.P. 2014. Aktivitas Harian dan Penggunaan Habitat Kukang Jawa (*Nycticebus javanicus*) di Talun Desa Cipaganti, Garut, Jawa Barat. [Skripsi]. Depok: Universitas Indonesia.

Rode-Margono, E.J., Nijman, V., Wirdateti, W. and Nekaris, K.A.I. (2014). Ethology of the critically endangered javan slow loris *Nycticebus javanicus* E. Geoffroy Saint-Hilaire in West Java. *Asian Primates Journal 4(2): 27-41*.

Rowe, N. 1996. *The Pictorial Guide to The Living Primates*. New York: Pogonian Press.

Santosa, Y. 1990. Pola Penggunaan Ruang dan Organisasi Sosial Rusa Sambar (*Cervus unicolor*) di Bukit Lindung Soeharto, Kalimantan Timur. Bogor: Fakultas Kehutanan, IPB.

Supriatna, J. 2019. *Field Guide to the Indonesia Primates*. Jakarta: Yayasan Pustaka Obor Indonesia.

Supriatna, J. and Ramadhan, R. 2016. *Pariwisata Primata Indonesia*. Jakarta: Yayasan Pustaka Obor Indonesia.

Supriatna, J. and Wahyono, E.H. 2000. *Panduan Lapangan Primata Indonesia*. Jakarta: Yayasan Obor Indonesia.

Sjahfirdi, L., Putri, A.R.M., Maheswari, H., Astuti, P., Ningtyas, D.P. and Budiarti, G.R. 2009. Perilaku makan dan preferensi orangutan (*Pongo pygmaeus* Linnaeus 1760) muda di penangkaran. Seminar Nasional MIPAnet. Bridging MIPA and Society. Denpasar, Bali.

Tanudimadja, K. 1978. Ethology. Sub Proyek Latihan Animal Wildlife Conservation. Bogor.

Winarti, I., 2011. Habitat, Populasi, dan Sebaran Kukang jawa (*Nycticebus javanicus* Geoffroy 1812) di Talun Tasikmalaya dan Ciamis, Jawa Barat. [Thesis]. Bogor: Sekolah Pascasarjana Institut Pertanian Bogor.

Wiens, F. 2002. Behavior and Ecology of Wild Slow Lorises (*Nycticebus coucang*): Social organization, infant care system dan diet [Disertation]. Bayreuth (DE): Bayreuth University.

Wiens, F. and Zitzmann, A. 2003. Social structure of the solitary slow loris *Nycticebus coucang* (Lorisidae). *Journal of Zoology 26: 35-46.*

Wiens, F., Zitzmann, A. and Hussein, N.A. 2006. Fast food for slow lorises: Is low metabolism related to secondary compounds in high-energy plant diet?. *Journal of Mammalogy 87: 790-798.*

Yayasan IAR Indonesia. 2011. Kukang di Indonesia: Di tengah maraknya perdagangan (gelap) satwa. Bogor: Intenational Animal Rescue.

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MacArthur, R.H. & Wilson, E.O. (1967). The Theory of Island Biogeography. Princeton University Press, Princeton, USA.

Sutherland, W.J. (ed.) (1998). Conservation Science and Action. Blackwell Science, Oxford, UK.

Beck, B.B., Rapaport, L.G. & Stanley Price, M.R. (1994). Reintroduction of captive-born animals. In Creative Conservation: Interactive Management of Wild and Captive Animals (eds P.J.S. Olney, G.M. Mace & A.T.C. Feistner), pp. 265-286. Chapman & Hall, London, UK.

Traeholt, C., Bonthoeun, R., Rawson, B., Samuth, M., Virak, C. and Sok Vuthin (2005). Status review of pileated gibbon, Hylobates pileatus and yellow-cheeked crested gibbon, Nomascus gabriellae, in Cambodia. Fauna & Flora International, Phnom Penh, Cambodia.

Sun H. (2000). Status of the tiger and its conservation in Cambodia. MSc thesis, University of Minnesota, Minneapolis, USA.

IUCN (2010). 2010 IUCN Red List of Threatened Species. http://www.redlist.org [accessed 1 February 2011].

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Indonesian Journal of Applied Environmental Studies

journal.unpak.ac.id
Volume 4 • Number 1 • April 2023
P - ISSN : 2722 - 0133
E - ISSN : 2722 - 0141

P-ISSN: 2722 - 0133 E-ISSN: 2722 - 0141

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Supported by Belantara Foundation